AUTOMATION

DECEMBER 1961

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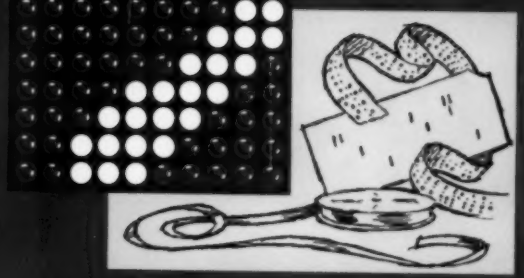


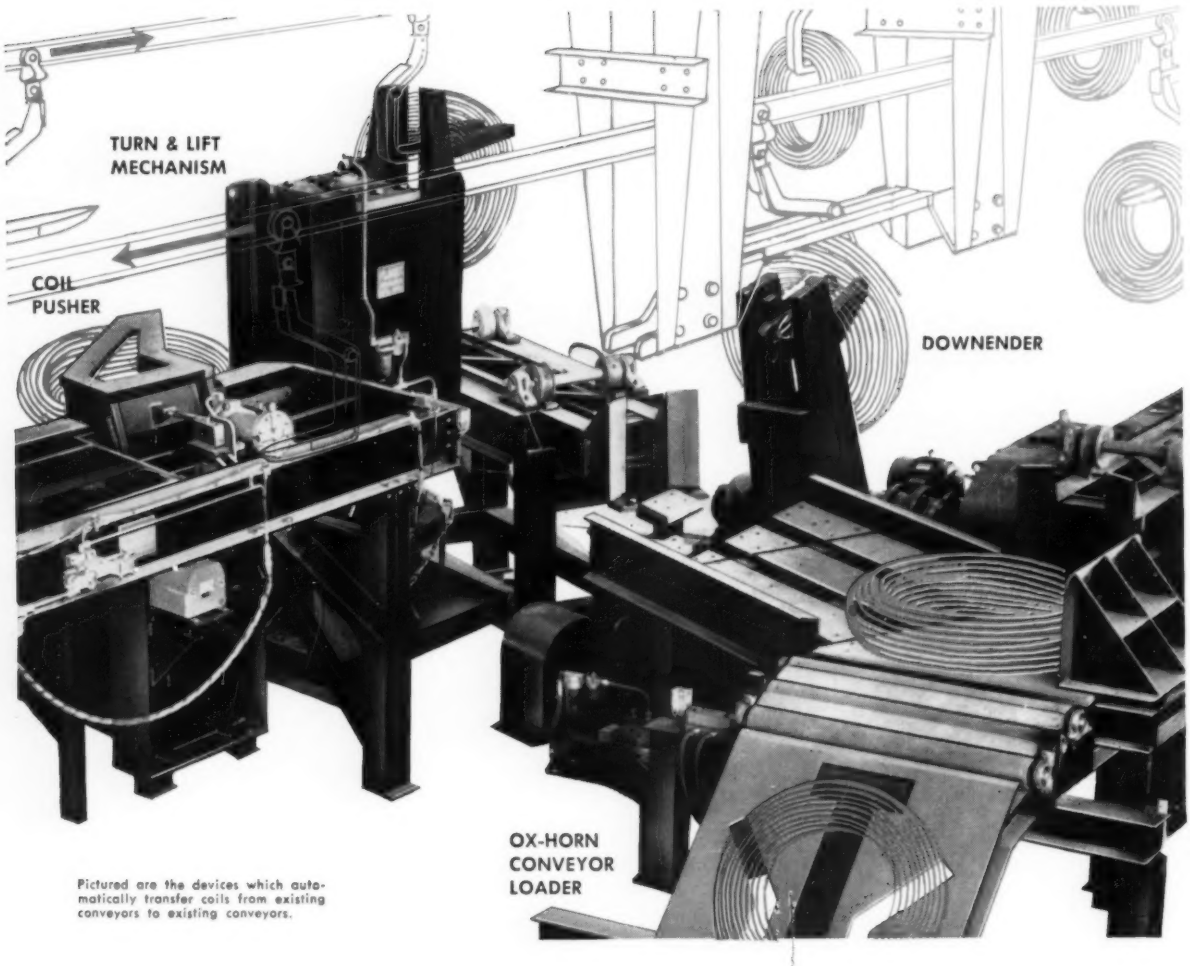
Reading Printed Data Electronically

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- A Project Analysis
- Organizing for Effective Production Control
- Controlling Motion
- Hydraulic Circuits to Avoid Overheating

CONTENTS—PAGE 3

A PENTON PUBLICATION



Pictured are the devices which automatically transfer coils from existing conveyors to existing conveyors.

Planet Versatility saves money...

NEW AUTOMATIC COIL HANDLING SYSTEM UTILIZES EXISTING CONVEYORS

This custom-engineered automatic coil handling system is an example of how *Planet Versatility* saved one of America's largest steel mills substantial capital investment by designing a system to load and unload *existing* conveyors.

When modernizing its 10-inch bar mill to handle larger, 2,000-pound bar coils, this firm called in Planet Corporation to engineer, fabricate and install an automatic handling system. Instead of scrapping all existing equipment, Planet engineered devices to automatically transfer red-hot bar coils from *existing* conveyors to *existing* conveyors.

The transfer equipment designed by Planet, plus synchronization of the existing conveyors, converted the old operation into a completely automatic, 15-second cycle system.

If your plant has a materials handling or automation problem, "PV"—*Planet Versatility*—will save your time in finding cost-saving, efficiency-increasing solutions. Let Planet demonstrate how its versatile engineering skill and manufacturing know-how can help you. It has paid leading manufacturers in nearly every industry to plan with Planet *. . . it will pay you too!* Write today.

Sales Offices in Principal Cities in the United States and Mexico

PLANET CORPORATION

- *Engineered Handling Systems*
- *Automation Equipment*
- *Mill & Foundry Equipment*

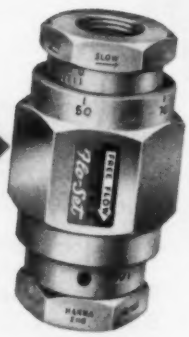
1810 SUNSET AVENUE
LANSING, MICHIGAN

Circle 651 on Reply Card

. . . MICROMETER SETTING

For Exacting Flow Control

HANNA *Flo-Set*® VALVES



Flo-Set 1000

Hydraulic pressure to 1000 psi
Sizes ¼", ⅜", ½", ¾"
Temperatures to 250°F

Flo-Set

Air, Oil, water operation to 250 psi
Sizes ¼", ⅜", ½", ¾"
Temperatures to 250°F

OTHER HANNA VALVES
Include solenoid, pilot, hand and foot operated types

FOR AIR • OIL • WATER • OTHER FLUIDS

REGULATING cylinder speeds or controlling fluid flow of air, oil or water is so simple with Hanna Flo-Set Valves . . . you need only turn the valve body one revolution to adjust from zero to full pipe capacity. Micrometer-type graduations are numbered to indicate the percentage of pipe capacity. Once set, the position can be locked to avoid accidental change. Future resetting to a predetermined flow requires no guesswork.

Hanna Flo-Set Valves allow full flow in one direction—controlled flow in the opposite. Used in pairs, they regulate independently cylinder instroke and outstroke speeds. Hanna Flo-Set Valves assure uniform speed, smoother action and improved performance of cushioned and non-cushioned cylinders.

Valve sizes are ¼", ⅜", ½", and ¾" . . . a ¼" Jr. model, without graduations or locking collar, is available for light piping and tubing.

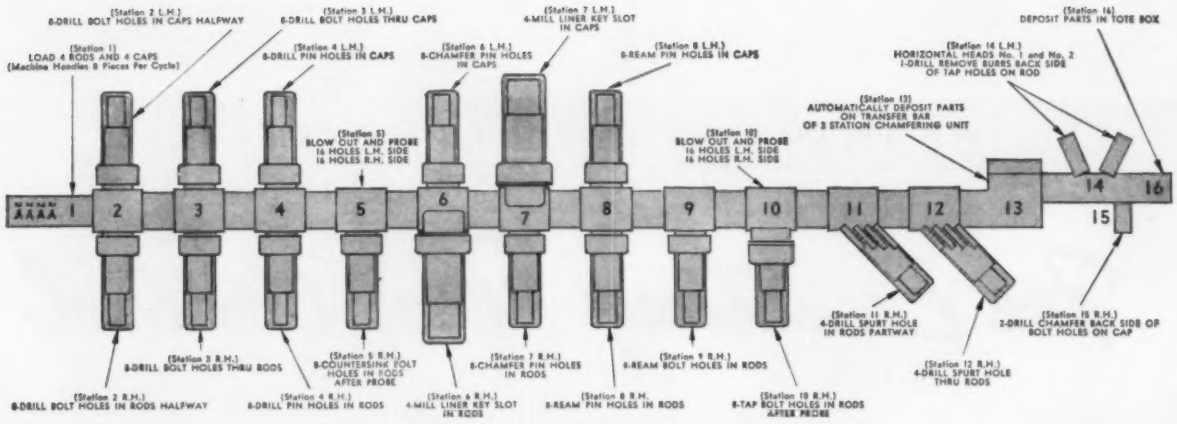
Whatever your problem of precision fluid control may be—you will find the best answer in Hanna Flo-Set Valves—designed, built and guaranteed by Hanna's 50 years of experience in hydraulics and pneumatics.

WRITE FOR LITERATURE AND COMPLETE DETAILS,
or consult your classified telephone directory or Thomas' Register for your nearest Hanna representative.

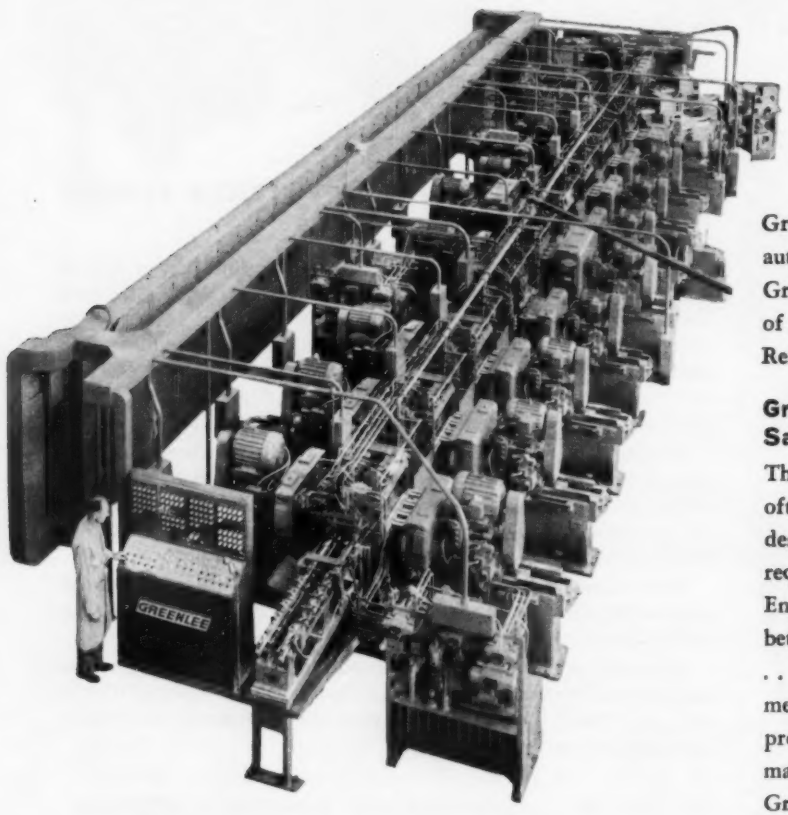
Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES

1753 Elston Avenue • Chicago 22, Illinois


(Station 1) LOAD 4 RODS AND 4 CAPS (Machine Handles 8 Pieces Per Cycle)
(Station 2 L.H.) 8-DRILL BOLT HOLES IN CAPS HALFWAY
(Station 3 L.H.) 8-DRILL BOLT HOLES THRU CAPS
(Station 4 L.H.) 8-DRILL PIN HOLES IN CAPS
(Station 5) BLOW OUT AND PROBE 16 HOLES L.H. SIDE 16 HOLES R.H. SIDE
(Station 6 L.H.) 8-CHAMFER PIN HOLES IN CAPS
(Station 7 L.H.) 4-MILL LINER KEY SLOT IN CAPS
(Station 8 L.H.) 8-REAM PIN HOLES IN CAPS
(Station 10) BLOW OUT AND PROBE 16 HOLES L.H. SIDE 16 HOLES R.H. SIDE
(Station 13) AUTOMATICALLY DEPOSIT PARTS ON TRANSFER BAR OF 2 STATION CHAMFERING UNIT
(Station 14 L.H.) HORIZONTAL HEADS No. 1 and No. 2 1-DRILL REMOVE BURRS BACK SIDE OF TAP HOLES ON ROD
(Station 16) DEPOSIT PARTS IN TOTE BOX
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
(Station 2 R.H.) 8-DRILL BOLT HOLES IN RODS HALFWAY
(Station 3 R.H.) 8-DRILL BOLT HOLES THRU RODS
(Station 4 R.H.) 8-DRILL PIN HOLES IN RODS
(Station 5 R.H.) 8-COUNTERSINK BOLT HOLES IN RODS AFTER PROBE
(Station 6 R.H.) 4-MILL LINER KEY SLOT IN RODS
(Station 7 R.H.) 8-CHAMFER PIN HOLES IN RODS
(Station 8 R.H.) 8-REAM PIN HOLES IN RODS
(Station 9 R.H.) 8-REAM BOLT HOLES IN RODS
(Station 10 R.H.) 8-TAP BOLT HOLES IN RODS AFTER PROBE
(Station 11 R.H.) 4-DRILL SPURT HOLE IN RODS PARTWAY
(Station 12 R.H.) 4-DRILL SPURT HOLE THRU RODS
(Station 15 R.H.) 2-DRILL CHAMFER BACK SIDE OF BOLT HOLES ON CAP

British Automobile Manufacturer Uses Greenlee Transfer Machines to Produce Connecting Rods



Greenlee was selected by a large automobile manufacturer in Great Britain to help solve the problem of machining connecting rods and caps. Results: 320 connecting rods every hour.

Greenlee "Cooperative Engineering" Saves You Time and Money

The need for increased efficiency often requires new machines . . . designed and built to meet your requirements. "Cooperative Engineering" is an exchange of ideas between you and Greenlee engineers . . . ideas that result in the best methods and machines to produce your products. This 16 station transfer machine is an excellent example of Greenlee "Cooperative Engineering". Investigate "Cooperative Engineering"! It will mean increased profits for you.

PRODUCTION MACHINERY

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SINCE 1863 — 2002 Mason Avenue, ROCKFORD, ILL., U.S.A.

TRANSFER MACHINES • SPECIAL MACHINES • AUTOMATIC BAR MACHINES • WOODWORKING MACHINES AND TOOLS
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The Magazine of Automatic Manufacturing Operations

DECEMBER 1961
Vol. 8 — No. 12

AUTOMATION®

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REGULAR DEPARTMENTS

Around the Triangle, 4
Automation Outlook, 9
Automation News, 13
Meetings and Events, 28
Detroit Dateline, 33
International Scene, 37
New Equipment, 83
Advertised Product Index, 97
Equipment Index, 98
Readers' Reply Card, 99
New Components, 103
New Literature, 127
Abstracts, 135
Confidential File, 142
Editorial Index, 144
Advertiser Index, 147

EDITORIAL OFFICES

Penton Building, Cleveland 13, Ohio

Double Challenge, 41

EDITORIAL—increasing use of automation technology abroad couples with lower wage scales to provide bigger contest in world markets.

A Project Analysis, 42

SPECIAL REPORT—representatives of the user and the builder trace the development of a high-speed automatic assembly machine.

Shall We Automate?, 43

E. H. GRUMICH—discusses the user's viewpoint and the product and methods which led to justification of the automatic machine.

Preparing the Proposal, 48

C. C. HOLLOWAY—successful achievement was based on analysis of tangible and intangible factors by joint efforts of builder and user.

Assembling Pen Caps, 50

L. C. TULLIS—pictorial presentation describes features of the machine which can produce as many as 2880 six-part assemblies per hour.

Organizing for Effective Production Control, 55

B. W. CURRY—using customer service as the key concept enables company to devise straightforward and meaningful order handling system.

Integrated Cleaning-Coating Line, 58

PAINTING STRIP—continuous line cleans, surface treats, coats, and cures aluminum or steel strip at speeds up to 150 feet per minute.

Reading Printed Data Electronically, 60

N. E. GOLOVIN—reading machine scans documents and provides coded signals for input to a computer.

Making Frozen Pies, 65

FOOD INDUSTRY—continuous processing line produces and packages 3500 frozen pies per hour in modern food plant.

Automation in Action, 66

PICTORIAL PRESENTATION—packaging caps, transferring pipe, gaging burden level, painting fixtures, interleaving greeting cards.

Sheeting Line Includes Automatic Inspection, 68

CULLING DEFECTIVE SHEETS—two inspection, shearing, and sorting lines remove sheets having pinholes, visual defects, or nonstandard gage.

Controlling Motion, 69

J. F. PECH—as shown by numerous examples, electric clutches and brakes can be combined in a variety of ways to obtain precise control.

Hydraulic Circuits to Avoid Overheating, 79

W. BROWN—good circuit design can eliminate or minimize sources of unwanted heating in hydraulic circuits.

around the triangle

NON-ELECTRIC PLATING

An acid immersion tin plating process that requires no electrical current has been developed by MacDermid Inc. The process produces a uniform corrosion-resistant deposit of tin on copper, copper alloys, lead, tin-lead alloys, and solder. Even in deep recesses and blind holes, the coating can be applied in less than a minute. A suitable application is on copper contacts for electrical equipment and for plating the inside of copper water cooling coils.

FILM PACKAGE ASSEMBLES LEAD SHIELD

A continuous strip film package that is used for the inspection of welded pipe has been developed by General Magnaplate Corp. The film is a flexible x-ray type shielded with plastic-coated lead foil sealed with tape. As the film is withdrawn from a light-tight box, it is automatically covered with the lead foil shielding and tape sealed. Notations can be made over the foil with a ball point pen and the inscription will show up on the processed film.

VALVE DEVELOPED FOR HIGH-SPEED PRINTER

High-speed contact printer has an air valve that is basically two small slotted plates of phenolic laminate. The valve operates a diaphragm that holds photo print paper and negatives against a glass stage plate. Valve plates slide on each other to apply suction in a collapsible chamber under the glass and, after light exposure, admit air for diaphragm release and paper advance. The valve material is supplied by the Micarta Div., Westinghouse Electric Corp. It is unaffected by normal changes of temperature and humidity, and remains permanently flat to seal the valve ports. Up to 15 photos per minute can be printed on 9½-inch wide rolls, 1000 ft long by the printer developed by Staples-Hoppmann Inc. under contract with LogEtronics Inc.

TRANSISTORS AND DIODES SEALED WITH GLASS

Method for sealing high reliability into microminiature diodes and transistors has been developed by Components Div., International Business Machines Corp. Method begins with conventional fabrication of diodes or transistors on silicon wafers, followed by the oxide coating process. A special glass powder is then applied to the oxidized surface and the entire wafer is fired at more than 1500 F. This produces a film of chemically resistant glass only one ten-thousandth of an inch thick. The wafer is then cut with an ultrasonic knife into the tiny diodes or transistors, each retaining its permanent glass seal. Electrical contact to the devices is made through small holes etched through the glass and oxide.

COMPUTER TALKS BACK

A computer inquiry voice-reply device has been introduced by Remington Rand Univac Div., Sperry Rand Corp. The device enables transmission of inquiries to a Univac real-time computing system from a remote location and reception of stored computer-generated voice replies to the questions. Answers to pertinent questions which can be posed by the remote inquiry sets are stored on a magnetic drum at the computer site. After a message has been processed, the computer selects the appropriate reply from the drum and sends it back over the telephone lines to the inquiry set location. Forty sliding levers on the inquiry set can be positioned to correspond to individual letters or numerals in a query. The operator then obtains a telephone connection with the computer and the inquiry is transmitted in about two seconds. The voice reply begins immediately and takes from 3 to 5 seconds to transmit.

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Penton Building, Cleveland 13, Ohio
Main 1-8260

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BUSINESS STAFF

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BPA NBP

Fluid Power NEWS

OILGEAR 40 Years of Fluid Power

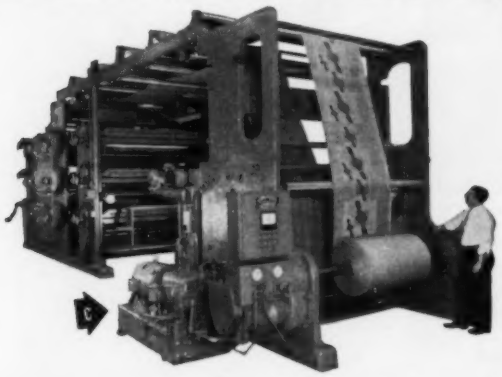
Report No. 12,301 — From Oilgear *Application-Engineering* Files

HOW OILGEAR *Any-Speed* DRIVE SYSTEMS ON *SCHMUTZ* 6-COLOR PRINTING PRESSES HELP BOOST PERFORMANCE, EFFICIENCY, ECONOMY, CONVENIENCE — IN LESS SPACE

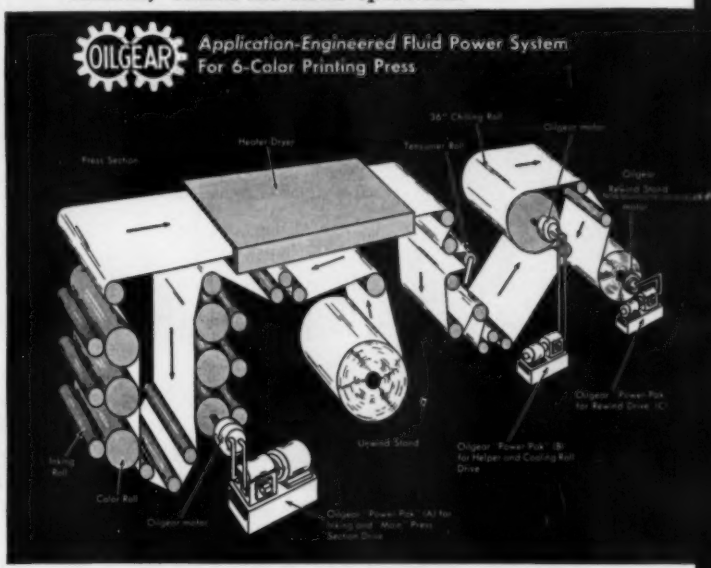
CUSTOMER: *Schmutz Manufacturing Company, Louisville, Kentucky.*

PROBLEM: Main and rewind drives with control systems for web-fed, 6-color printing presses for printing packaging stock — from 50 or 60-lb kraft, to container and food board. Web widths vary from 40"to 84", with impression "repeat" varying from 14" to 84".

REQUIREMENTS: 1. Constant or absolute tension on the press section to provide "dot-to-dot" register over an infinitely variable (stepless) speed range from 0 to 1000 feet per minute . . . and hold set speed and tension without variation regardless of fluctuations in load, electrical power input, or temperature. 2. Provide either constant or tapering tension for rewind — from 4" cores to 40" or 60" dia. rolls. 3. Must be economical from the standpoints of installed cost — operation and maintenance — floor space — and electrical power input. 4. Clean, quiet operation — with minimum heat dissipation. 5. To be "packaged" or pre-assembled for simplicity and speed of installation. 6. Eliminate, if possible, the long lineshaft drive that "closed up" one side of the press. 7. Be capable of dependable, trouble-free, continuous, 'round-the-clock operation.



ABOVE: Rewind end of an Oilgear-equipped, 84" Schmutz High Speed Press — with 84" maximum impression repeat, speed range from 0 to 1000 fpm — with constant acceleration and deceleration rates. Oilgear Rewind Drive, indicated, can hold in stalled condition indefinitely — follow press speeds and rewind from a 4" core to 60" roll. The variable, constant or drooping tension characteristics with absolute constant or decreasing tension — without any steps whatsoever — enable this Oilgear-powered 6-color press to hold register closer than previously experienced.



SOLUTION: Three separate Oilgear Servo-Valve-Controlled Pump and Motor Drives to provide stepless, infinitely variable speed control. Fully interlocked feedback systems hold speeds and tensions to a new high degree of accuracy unobtainable with the adjustable speed electrical drives formerly used. An Oilgear "Plus" feature — "memory" — permits the press to be stopped for periods of several hours, and if not reset, will automatically resume operation at the identical former speed and tension. Space requirements are drastically reduced — *Oilgear Direct-Drive,* Fluid Power Motors are smaller than the gear reducers formerly required — and space consuming power rectifiers are eliminated. Operating economy has been improved — Oilgear Drives use less than ½ the former input power. Oilgear Drives do not require high-speed blowers for cooling — are whisper-quiet in operation . . . can hold stall-speed indefinitely without overheating. Another advantage—*lower installed cost.* These are some of the major advantages that help convince Schmutz to "join the swing" to Oilgear Drives and Control Systems . . . user satisfaction is, of course, the ultimate factor.

For example, one Schmutz customer reports — *"Our press is in operation 24 hours per day — 6 days per week. We can measure our Oilgear maintenance in nickels per year . . . with previous drives we had to carry $1000 worth of tubes in stock."*

This is merely one of innumerable "problem drives" solved by Oilgear Application-Engineering teamwork — and Oilgear ANY-SPEED Drives and Control Systems . . . for new standards of performance — greater accuracy, precision control of speeds, torques, tensions . . . for new economy of operation, installation, maintenance, and valuable floor space . . . for longer, more dependable life. These are sound, basic, *installation-proved* reasons why there are more and more Oilgear users in the paper, printing and converting, marine, food and beverage, chemical, pharmaceutical, primary metals, metal-working, textile, rubber, military, and other industries who all agree that . . .

"for the lowest-cost-per-year . . . it's OILGEAR!"

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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Application-Engineered Fluid Power Systems

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Phone: Mitchell 5-6715 — Direct Distance Dialing Code — 414

He's setting up a milling job.

Each plug pegged into this Telematic control panel determines an event in a milling cycle.

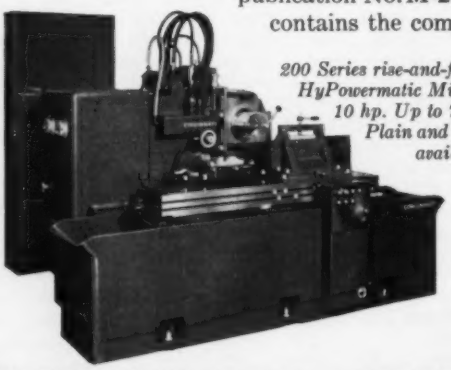
When all the plugs are placed, the operator will have set up a complete automatic cycle—in minutes. Tomorrow—or next month—he can reset the plugs for an entirely different job.

Functions controlled and coordinated by Telematic are these: Table feed right or left. Spindle carrier feed up or down. Table or carrier rapid traverse. Constant feed (slow feed for precision positioning). Dwell. Quill advance (or retract). Tracer. Fixture (clamp or index). Spindle.

Up to 24 separate events can be programmed on the standard panel. Events are initiated by trip dogs on the table and spindle carrier.

Literally thousands of cycles are possible, including complex multiple-operation work requiring successive cuts to different depths. Tolerances can be held to ± .001″. For cycles intended to be repeated from time to time, templates are provided to speed up plug positioning.

Telematic Control was developed to program our 200 Series rise-and-fall HyPowermatics. It gives you the advantages of automatic milling plus versatility at a fraction of the cost of other systems. Ask us to send publication No. M-2020-2 which contains the complete story.

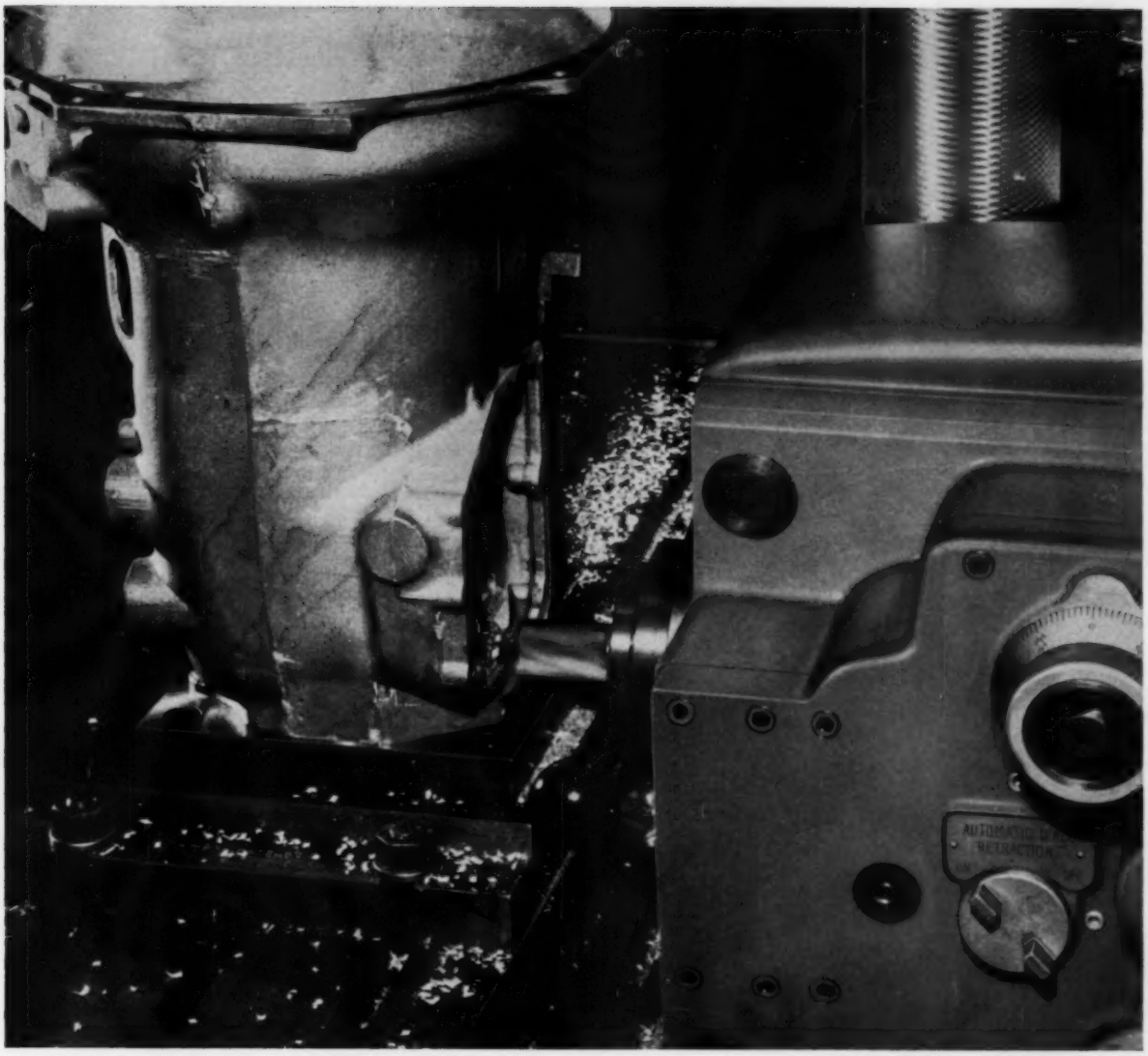


200 Series rise-and-fall HyPowermatic Milling Machine. 10 hp. Up to 72″ table travel. Plain and duplex styles available.

CINCINNATI

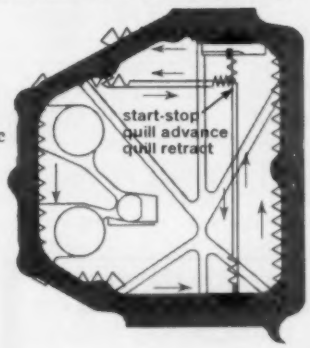
BUILDERS OF FINE MACHINE TOOLS: KNEE TYPE AND BED TYPE MILLING MACHINES • DIE SINKING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO



See what you can do with Telematic Control

Part: Gear case.
Material: Aluminum
Operation: Mill cover face and two scallops.
Machine: CINCINNATI HyPowermatic equipped with Telematic Control.
RPM: 2000
Feed: 19″/min.
Depth of cut: ⅛″
Time per piece: 2.47 min.



Cycle: 1. Carrier rapid down. Quill advanced. 2. Carrier feed down. (Dwell) 3. Carrier rapid up. 4. Carrier feed up. (Dwell) 5. Carrier rapid down. 6. Quill retract. 7. Table rapid right. 8. Table feed right. 9. Carrier feed down. 10. Table feed left. 11. Carrier feed down. 12. Table feed left. 13. Carrier feed up. 14. Table feed right. 15. Carrier feed down. 16. Table rapid left. 17. Table constant feed left. 18. Quill advance. 19. Reset. Ready for next cycle.

CUTTER AND TOOL GRINDERS • ELECTRICAL MACHINING EQUIPMENT

CINCINNATI®
MILLING MACHINE DIVISION

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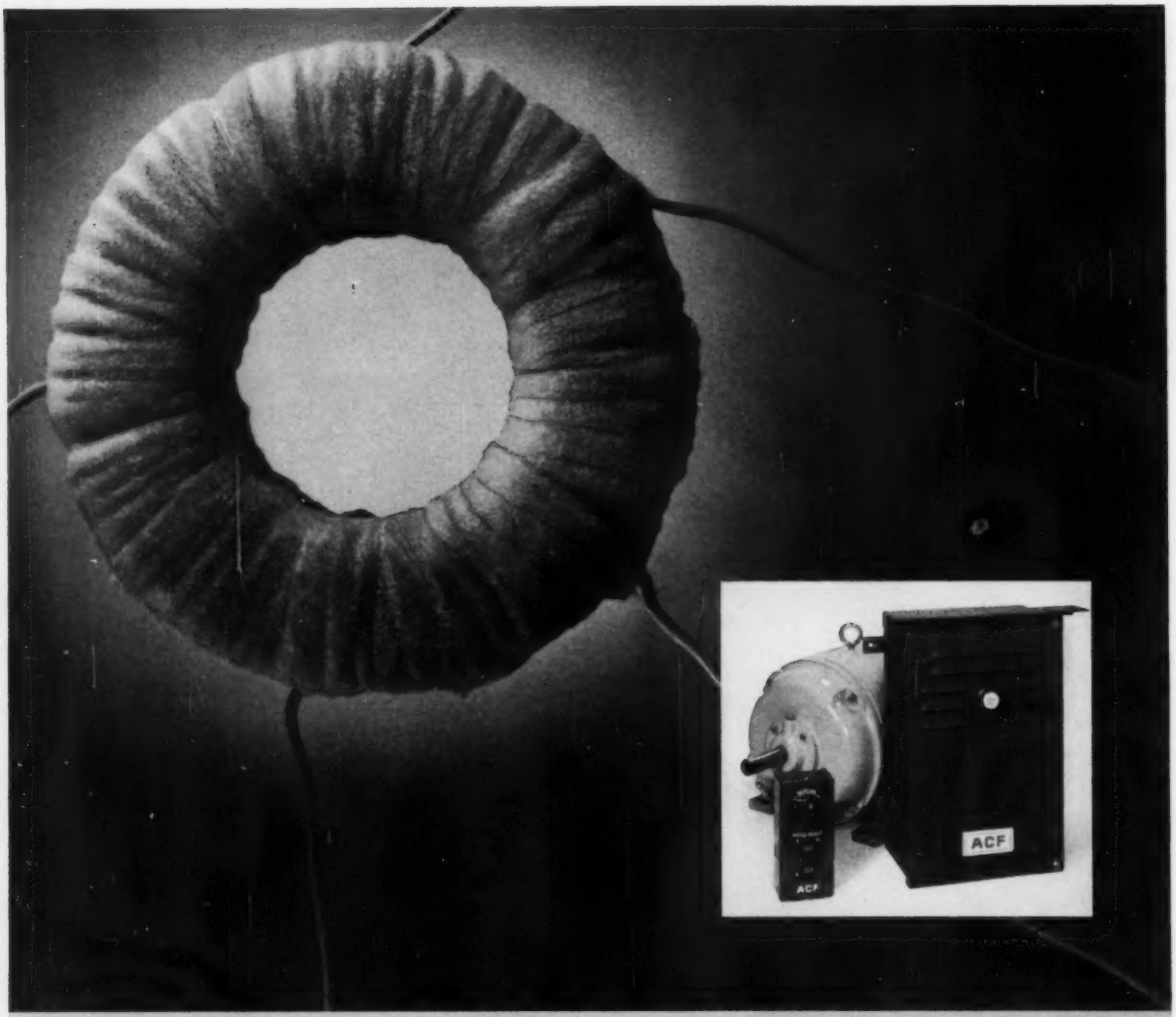


MOTOR CONTROL "NERVE CENTER"

ACF ADJUSTABLE SPEED CONTROLS respond instantly to speed variations due to load changes. The patented ACF Magnetic Triggering "nerve center" provides precise control of firing angles; avoids response to spurious transients; gives driving power under extremes of temperature, line voltage and frequency. ACF drive systems from 1/100 to 15 horsepower are easily installed and are superior in any application requiring adjustable speed at constant torque.

ACF STEPLESS MOTOR CONTROLS operating from an AC source, are smaller, lighter, more economical than competing systems—give smooth, precise regulation over a wide range of speeds regardless of load variations. The "nerve center" eliminates the need for tubes and insures instantaneous, repeatable control. ACF compact drive systems, for both fractional and integral HP DC operation, are available as off-the-shelf items.

For full information, write or call Paramus Plant, 11 Park Place, Paramus, N. J. Telephone: COlfax 1-4100.

ACF ELECTRONICS
DIVISION

ACF INDUSTRIES

automation outlook

ROGER W. BOLZ, Publisher and Editorial Director

BROAD MANUFACTURING SYSTEM APPROACH is gradually gaining acceptance as the most effective means for obtaining the production advantages possible through automation. More and more it is becoming obvious to professional groups that single, isolated areas of endeavor cannot easily achieve the desired cost advantages owing to the extreme overlap of influences present.

In the deliberations of the Systems and Procedures Association ISM meeting held in Cleveland recently this fact again came to the fore. Whether it is ISA, AIIE, IRE, or SPA, sincere study usually leads to the conclusion that the practical economic answer is to be found in a redevelopment (from their own specialized base) of the basic manufacturing system. Results of experience, however, show that opportunities available to industry can be turned to profitable advantage *only* by making changes necessary throughout the enterprise to implement the system concept whether it influences product design, processing equipment, handling methods, automatic controlling means, or data.

The problem is basically one of manufacturing engineering with all areas of support specialties fulfilling their designated part in the master concept. Without such a master concept the likelihood of succeeding to the next higher level of sophistication in manufacturing—automation—is not a very sure bet. It is no different than the rendering of a musical masterpiece by a symphony orchestra. Unless there is a master concept —the score written by the composer—and unless each segment of the orchestra plays its proper part perfectly balanced and timed as conceived, the result is unpleasant. Even though every player must be an experienced professional, there can be no substitute for the Bruckners who conceive or for the Bernsteins who direct and carry out the master concept.

Oliver Evans rightly should be classed as the first man to break with the departmentalized, fragmentized approach of centuries. In developing his novel manufacturing systems approach to continuous automatic flour milling back in 1783, Evans received little but criticism. Yet to this day his master concept is still valid and the fact that he did invent the use of continuous conveyor handling in-process is unheralded. Centuries of experience and practice that molds most men in the myopic pattern of the past is slow to dissipate. The tremendous need and urgency today is still for manufacturing systems engineers who can envision and create the master concepts needed. Evans' invention opened a new chapter in the history of manufacture. Almost 180 years later breakthrough to fuller understanding is imminent.

EXPERT COMMENT on the situation concerning machine tool activity here and abroad seems to miss an important part of the picture.

automation outlook

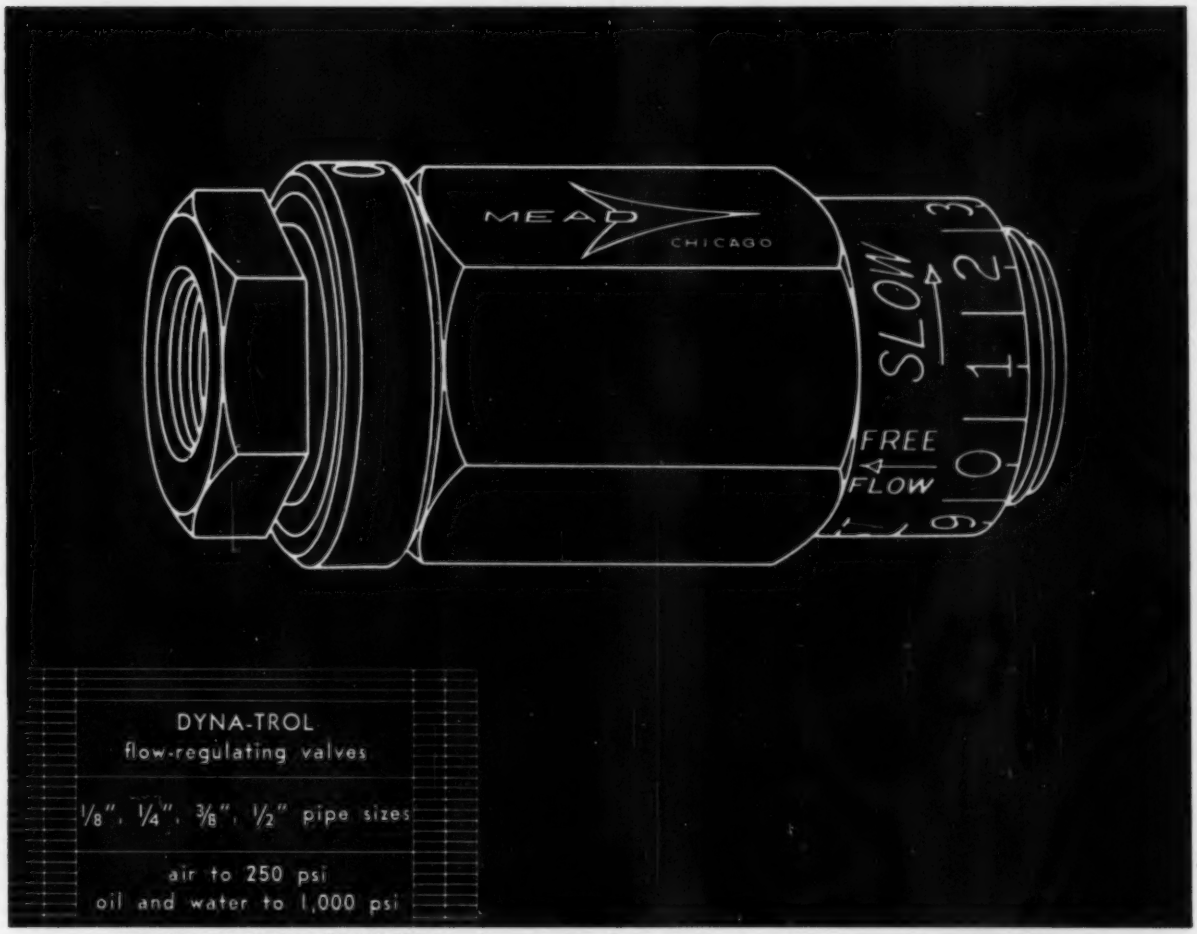
To conclude that all U. S. companies must replace their older machine tools with new ones to match the present age status abroad harbors a fallacy. To effectively raise our productivity requires planning and equipment far more radical in concept than a mere percentage advance in presently used methods. This requirement is becoming more obvious every day to thoughtful executives. On one hand it will result in increasing sales of numerically controlled machines, on the other, more special systems. In general, there is no common ground for meaningful comparison except to take good note of the growing amount of automated machinery being purchased abroad.

WHO SPEAKS FOR PROFIT? was the very timely topic of E. J. Hanley, president of Allegheny Ludlum Steel Corp. at a recent AIA meeting. Not only labor overlooks this basic facet of our economy but even many businessmen, in the adherence to outmoded practices like free engineering, have failed to recognize that fair and honest return for services renedered is fundamental. Says Mr. Hanley, "I think we sometimes overlook this important fact in dealing with our labor problems: no one needs profit in a business so much as the worker who wishes to retain his job in that business." It will bear repeating.

OCCASIONALLY WE BECOME IMPATIENT with manufacturers and laymen who fail to recognize the three-phase integrated character of automation technology. However, we are somewhat placated by the comment of Chicago University's Prof. John R. Platt in *Saturday Review* that most scientists and engineers spend their lives reinventing the wheel. "What is not so often realized is that science is incomplete in serious ways, with gaps that scientists themselves, tied to their narrow specialties, hardly realize the existence of."

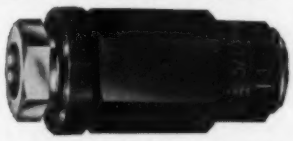
"WE MUST CEASE BEING CHILDREN playing at games in this great international market place." Hickman Price, Jr., Assistant Secretary of Commerce for Domestic Affairs, speaking in Cleveland recently made this emphatic comment to highlight the need to raise efficiency in the years ahead. If U. S. manufacturers are to meet the challenge of foreign productive enterprise, a re-evaluation of the seriousness of our work and labor outlook is imperative, Price says, if we are to retain our position as a first-rate producer of goods.

IN-PLANT DEVELOPMENT of production equipment and processes is growing. Survey of more than 18,000 plants shows that one-third now have individuals or groups assigned responsibility for automation development. Over 80 per cent of the respondents indicated they now do some or all such research and development engineering work. A new survey by the National Science Foundation confirms this trend. Only one-half the total of applied research and development funds expended by the machinery industry was allocated to machinery, a significant part being for non-manufacturing equipment. However, a substantially equal total amount was expended by user industries for their own production needs.



PROBLEM: how to replace a 1/4" valve with a less-costly 1/8" valve (and get extra precision in low-flow ranges)

SOLUTION: NEW MEAD DYNA-TROL VALVE



Check these design advantages of the new MEAD DYNA-TROL flow-regulating valve:

- Adjusting sleeve — easily rotated by hand — locks to any setting and cannot be accidentally removed from valve body
- Calibrated sleeve records settings for future reference
- Knife-edge variable orifice reduces flow distortion caused by viscosity changes in working medium
- No internal springs to cause malfunction
- All parts rust-proof
- Wide operating range: −40° F. to +250° F.

Small, economical MEAD DYNA-TROL flow-regulating valves can replace more costly valves of larger pipe size. Reason: Internal design permits pneumatic or hydraulic flow equal to full pipe area in both directions. The first 360° turn of the adjusting sleeve increases flow from zero to about 10% of potential — a new measure of precision in low-flow ranges. Successive turns accurately reach 100% of pipe capacity. To cut costs and give exacting control to piston speeds, specify MEAD DYNA-TROL valves to solve your flow regulating problems. For information on quick delivery, write to MEAD *today*.

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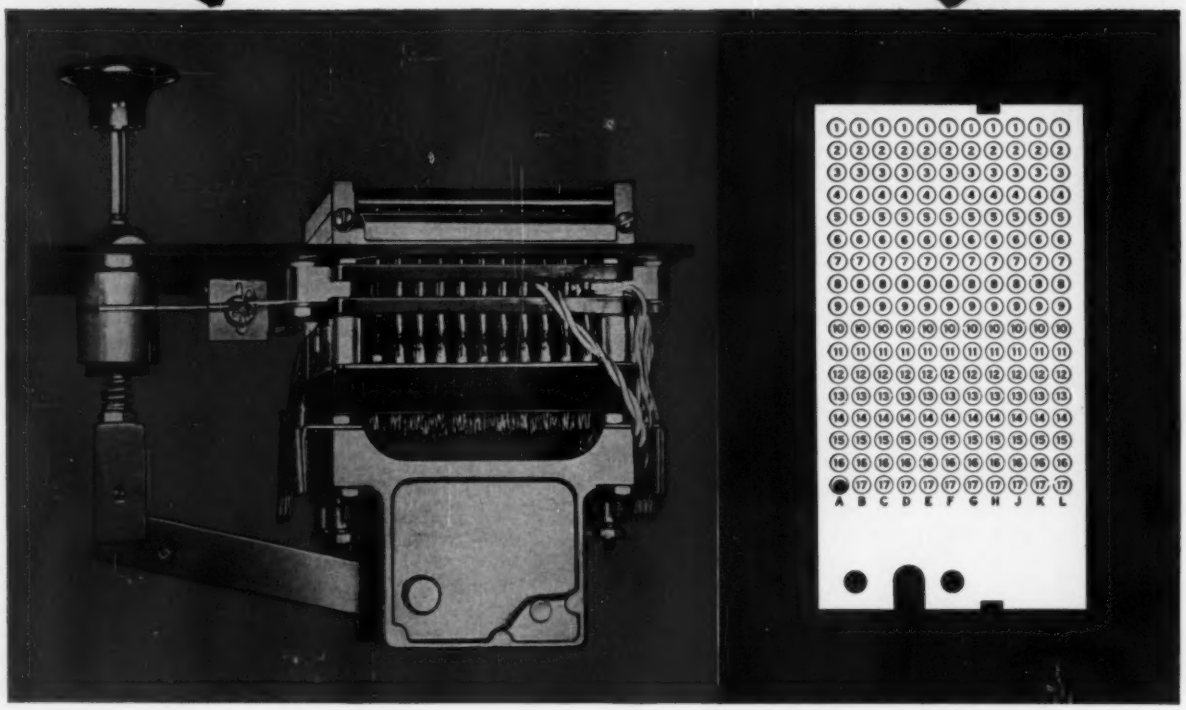

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Now, with the HICKOK Cardmatic® Card Reader, you can provide card-programming advantages at low cost. Make your product more versatile, simplify and speed set-ups, assure consistently uniform results, regardless of the operator's skill and experience.

The HICKOK Cardmatic® Card Reader is more than just a sensing device. It is an actual working switch with 186 individual contacts, contact-to-pin resistance of only 0.0025 ohms and current carrying capacity of up to 10 amperes. A rubberized vinyl card, 3" x 5⅝", is the programming medium; the absence of a hole in the card completes a circuit.

The Card Reader measures only 6⅞" wide x 7 13/16" long x 4⅝" deep below panel. The basic unit with standard wiring is priced at $250.00—F.O.B. Cleveland.

For more information, write for Form SP 260, containing complete specifications and describing various applications . . . There is no obligation.

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AUTOMATION news

Today's events and developments in the field of automation

SPLIT Cuts NC Programming Effort

PROGRAMMING system called SPLIT (Sundstrand Processing Language Internally Translated) has been developed at Sundstrand Corp. to prepare control media for numerically controlled machines. The system uses a simple vocabulary of symbols representing 14 major operations and 36 minor operations to direct an IBM 1620 computer in calculating machine tool instructions. Key to the system is a deck of cards that feed set up data into the computer. The computer stores this information in its memory.

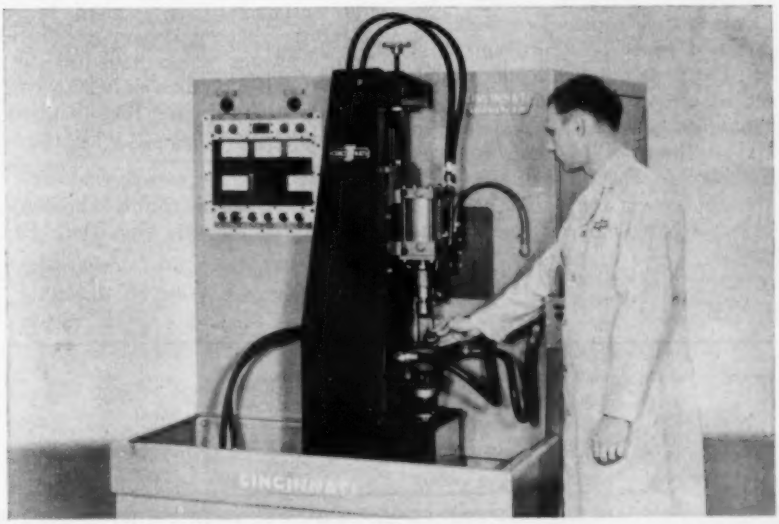
When establishing the program for a given workpiece, the computer must have a statement which contains the various combinations of the required major and minor operations and the numerical values associated with them. The major operation describes the type of operation to be performed and the minor operations specify the appropriate dimensions and required auxiliary functions to completely define the operation. Major instructions include those for automatic tool change, cut (along a prescribed path), move (from one point to another, but path not prescribed), contour (along the circumference of a prescribed circle), drill, bore, and float tap. Minor instructions include feed and speed, depth, direction (plus or minus on axis or clockwise or counterclockwise on circles), and coolant on or off.

Errors cannot always be detected by a planner when preparing statements to machine a given part, but the system is designed so that systematic checks are made on the symbolic words and numerical values while the statement is being processed. The computer can detect errors such as misspelled words, wrong signs, and incorrect values and will type out the kind of error that has been detected. It also types out the entire statement for error detection and other instructions, if necessary. The correct statement is then re-entered. Flexibility of the programming system allows it to be used with General Electric, Thompson Ramo Wooldridge, and Bendix controls.

Improvements Made In Baking Machinery

TREND to more automatic methods for baking bread and rolls is indicated by developments at American Machine & Foundry Co. They recently developed five new types of automatic bakery equipment. An English muffin machine will automatically cut the pieces of dough to the right size, shape the muffins, raise the dough, and put the muffins into the ovens for baking, all at a rate of 125,000 to 150,000 per day. A bread wrapper, using infra-red to seal the wrappers, can wrap approximately 30,000 loaves of bread per day in polyethylene.

A jet spray pan greaser electrically greases the pans in which bread is baked. An electric charge breaks up the oil into small globules and spreads it evenly in pans. The machine is set on casters and can be moved anywhere in the bakery. Production rate is 48,000 pans greased per day. Bread slicer has its own built in sharpener, and will slice 30,000 loaves per day. A push-



HEAT TREATING and assembly operations for gear and shaft assemblies are combined on one machine at Stanley Electric Tools, Div., Stanley Works. The assembly machine, built by Cincinnati Milling Machine Co., heats the gear teeth to below root diameter, press fits the gear on the shaft, quenches the assembly, and then tempers the gear teeth from a minimum hardness of R_c 55 to R_c 40-45. Heat power is provided by a 30 kw radio frequency unit which gives rapid heating confined to shallow case depth. An electronic rectifier on the rf heater permits power output to be varied, even under load, for operations requiring different temperatures in the same automatic cycle.

button cake and bread dough mixer is controlled from one centralized control panel. The machine has automatically timed mixing, and speed changes are controlled by a dial speed indicator at speeds ranging from 40 to 320 revolutions per minute.

CONTRACTS totaling $516,000 for the design and construction of three automatic lines for the manufacture of explosive devices have been awarded to the Ferguson Machine Co., Div., Universal Match Corp. The machines are to be delivered to Lone Star Ordnance Division, operated by Day and Zimmermann Inc. All functions of the equipment, including metering and compacting of powder, will be automatic. Production rate will be 320 completed assemblies per minute.

Computer Routines To Speed NC Programming

LIBRARY of specialized computer routines, to be known as the Mark Century Post Processor, will soon be available for every Mark Century numerical contouring control manufactured by General Electric Co. The post processor will make it possible for any APT-oriented computer to translate written English-language instructions into the punched paper tape programs used to direct automatic metalworking machine tools under Mark Century numerical control.

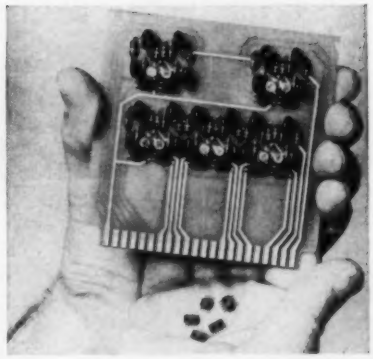
The library will contain routines for the company's full line of solid-state numerical contouring controls, from the two-motion type to the five-motion control. This is expected to be the first such complete library available to industry and including circular interpolation to speed programming. All routines in the Mark Century Post Processor will be written in the latest APT III format of relocatable Fortran computer language and Fortran Assembly Program. They will be compiled in modular form, allowing adaptation to special machine applications.

Tape Controls Drawing Machine

ENGINEERING MACHINE, for drafting, lofting, scribing, plotting, and production tape verification, has been developed by Ekstrom, Carlson & Co., to facilitate total use of mathematical formulas. The control system will accept the coordinate description of a part prepared and coded on punched tape by a digital computer and peripheral equipment. The tape controlled machine will accurately prepare an engineering drawing of such a part or assembly up to 60 by 144 inches in size in a continuous operation.

Drawing surface of the machine is in a plane 10 degrees off vertical, providing maximum accessibility to the surface and good visibility of the drawing. The drawing surface area is serviced by a complete vacuum system so valved that drawings of less than full size, or a number of such drawings, can be mounted at one time without masking.

FOURTH edition of the "Directory of Contract Packers and Their Facilities" has been published by the Packaging Institute Inc. The directory contains 593 listings, gives information on types of packaging done, facilities available, acceptable products, machinery in stock, and quality control features. The directory is available at nominal cost from PI headquarters, 342 Madison Ave., New York 17, N. Y.



FIVE microelectronic semiconductor networks shown are the functional equivalent of the entire conventional card above them. Six such circuits, each containing the equivalent of two dozen conventional components, can handle 90 per cent of the circuit functions of digital equipments. The solid circuit semiconductor networks, developed by Texas Instruments Inc., are derived from one standard silicon wafer. After all the electrical paths have been formed in the slice, it is then designated for one of the six circuits, and appropriate connections are made. Each silicon circuit is protected with oxide coating and deposited leads are used for point-to-point connections on the silicon bar. The completed silicon bars are then mounted in a hermetically sealed package.

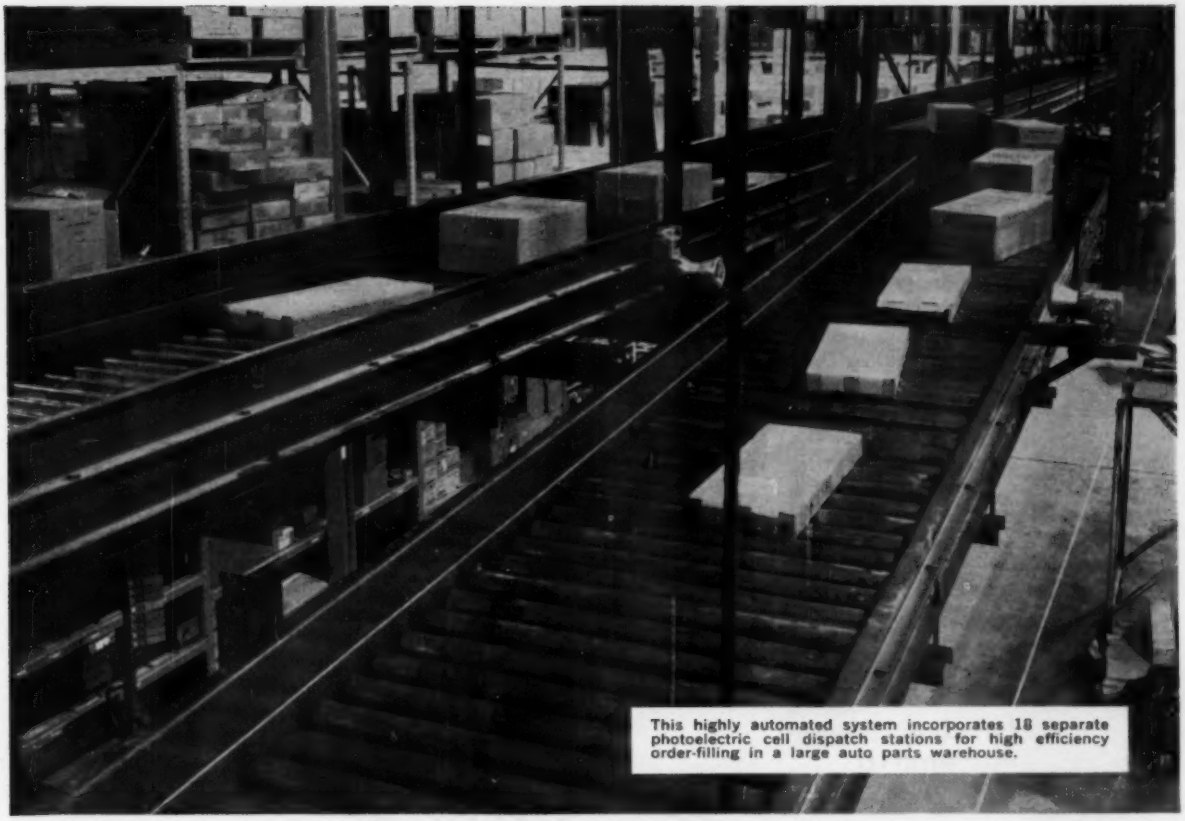
NAME of the American Society for Testing Materials has been changed to the American Society for Testing *AND* Materials. **Miles N. Clair**, president of ASTM, said, "The inclusion of the word *and* in the Society's name places added emphasis on the Society's research work in seeking knowledge of the nature of materials. It is a further reemphasis of one of the basic purposes for which ASTM was founded in 1898."

High-Speed Information Center to Be Set Up

PLANS to establish a communications and computer facility for com-

are you stuck?

DO YOU have problems concerning systems, equipment, or components for automated operations? You are invited to outline them and send them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. They will be printed in our Confidential File. Readers with solution suggestions are invited to submit them and should refer to the case number and title of the problem involved. For this month's Confidential File, turn to page 142.



This highly automated system incorporates 18 separate photoelectric cell dispatch stations for high efficiency order-filling in a large auto parts warehouse.

How you can make sure you get the right conveyor system for your particular job!

Perhaps we can help . . . and here is how! CSI-Farquhar can help you make sure you have the *right* type of conveyor system—one that's designed and engineered properly for the specific requirements of your production job. Our engineers have done many types of systems. Many of our customers have been happy to find that CSI-Farquhar already has had *particular* experience on their kind of job.

Draw on our experience with all types and styles!

The *right* conveyor system speeds up production and cuts down on maintenance. CSI-Farquhar has a wide experience *in almost every type of conveyor*—trolley, slat, wire mesh, power roller, power belt, pullveyors, gravity, spindle, trough, barrel handling and many other special styles. Thus you're sure of competent engineering and construction, based on solid experience.

Call in a CSI-Farquhar engineer!

He'll be happy to go over your conveyor problem with you. CSI-Farquhar has often come up with substantial savings on conveyor installations by suggesting time and money saving techniques in design, layout and construction.

This creative approach has worked for others. Why not let it work for you. Call us today.

SEND FOR 56 PAGE ILLUSTRATED BROCHURE

New Brochure No. 70 describes the complete service offered by CSI-Farquhar on engineered installations. It describes and illustrates many complex and specialized conveyor installations designed and built by CSI-Farquhar. Wide experience with all kinds of conveyors—trolley, in-the-floor types, spindle, mesh belt, barrel handling and many others. Our engineers can help you solve your conveyor problem efficiently and economically. Write for Brochure No. 70 today!

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Circle 660 on Reply Card

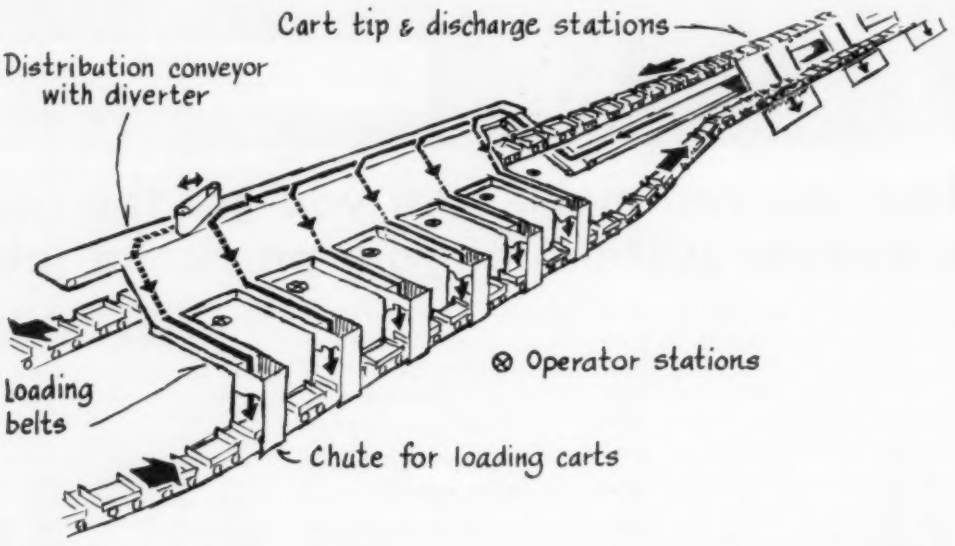
pany-wide service have been announced by Westinghouse Electric Corp. The center will be located on a 22-acre site in Braddock Hills borough near Pittsburgh. The computer used in the center will be a Univac 490, supplied by Remington Rand Div., Sperry Rand Corp. It will have the capacity to handle a wide variety of problems originating from different geographic locations simultaneously and will be arranged to distinguish between messages to be re-routed and data to be processed. The computer will automatically process teletyped orders and perform centralized inventory control functions for the company's products in more than 85 warehouses. Teletype messages will be routed by the computer from one company location to another on the leased teletype network.

CABRA Awards Program Underway

COPPER and Brass Achievement Awards Competition for 1962 is now underway. This is the fourth annual event sponsored by the Copper & Brass Research Association to honor outstanding new developments in the use or application of the copper metals in the United States. Engineers, designers, manufacturers, architects, or anyone associated with the use of copper, brass, or bronze can enter the competition. Entries can be new industrial or consumer products, production or manufacturing processes, redesigned products, or contributions to science and research that significantly involve use of the copper metals. First prize awards of $500 and bronze trophies will be given for the best entries submitted in two categories: Industrial and architectural. Nominations can be made through March 31, 1962. Entry forms with full details are available from CABRA, 420 Lexington Ave., New York 17, N. Y.

Distillation Unit Computer Controlled

A COMPUTER control system, developed by TRW Computer Co., Div., Thompson Ramo Wooldridge Inc., has been installed at the Tul-



IN AN EFFORT to keep pace with the rising mail volume, an automated system that helps expedite sorting of mail bags and parcels has been installed at the West Oakland Terminal of the Southern Pacific Co. The terminal processes an average of 1½ million pieces of mail per month. During the peak Christmas season the rate is as high as three million pieces. The automated system, which was developed and engineered by Link-Belt Co., is installed on a dock 38 ft wide and 1000 ft long. It sorts mail bags or parcels too large for bags at the rate of 60 per minute.

Mail is delivered to the terminal in railroad cars from all coastal and intercontinental points and by truck from northern California cities. Incoming bags of mail or parcels are dropped through unloading chutes to belt conveyors below. The belts, designed to handle 90 bags per minute, consist of a continuous line of six flat belts, 42 inches wide and totaling about 920 ft in length, each powered by its own drive equipment. This line of conveyors carries the mail up to a diverter arrangement.

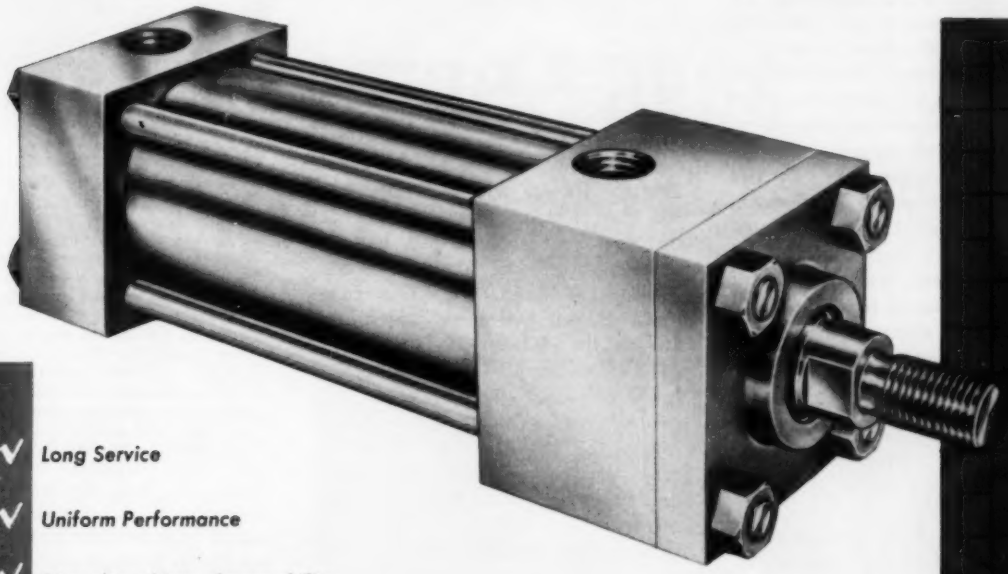
As the mail drops down from the traveling belt diverter, operators pull the bags onto short feeder belt conveyors which also serve as work counters. An operator identifies the destination of each mail bag and routes it in either of two ways. If the mail is destined for San Francisco, Marin County, or foreign civilian and military personnel, the operator shoves the bags into chutes directly in front of him, or to one side for manual sorting.

When the mail is destined for a discharge point assigned to the automatic sorting system, the clerk identifies the bag destination and depresses the appropriate key on his pushbutton console. Mail bags are sorted to 52 discharge points at the rate of 60 per minute by six mail dispatch clerks.

The bag moves forward and drops into a chute. Conveying medium for the electronic sorting system is a cart system which moves carts around the periphery of the terminal dock at a rate of either 150 or 300 fpm. As the bag is keyed into the electronic system, the system identifies an empty cart passing beneath the chute and automatically drops the bag into the cart.

When the cart arrives at the appropriate station a discharge cam is tripped, and the cart tilts, causing the mail to slide down the chute into the collecting area. There are 77 cart ejection points feeding the 52 discharge chutes. Some of the chutes discharge to one side of the dock for outgoing mail consigned for truck loading. The remaining chutes discharge to the opposite side of the dock for outgoing mail for train loading. After the mail has been accumulated and an outgoing railroad car or truck is to be loaded, the mail bags are placed on a portable belt conveyor extending into the door of the car of truck.

NEW O-M SQUARE-HEAD AIR AND HYDRAULIC CYLINDERS GIVE THE PERFORMANCE YOU EXPECT . . . AND MORE



- ✓ *Long Service*
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Air—(rated 200 psi)
Hydraulic—(rated up to 2000 psi)
Meet JIC Standards 1½" to 14" Bores

Made of the highest quality materials and seals, these new components combine modern design, the latest and best engineering advancements with O-M specialized "know how" and precision workmanship.

New Series "K" Air Cylinders
Construction features include brass cylinder barrel, chrome-plated, high tensile steel piston rod with a minimum yield strength of 90,000 to 100,000 psi. Rolled and machined steel heads and extra long cartridge-type rod bearing assure perfect alignment of piston rod.

New Series "L" Hydraulic Cylinders
Similar in many construction features to Series "K", but specifically designed for hydraulic service. Incorporate vee-type rod packing and a cylinder barrel of micro-honed steel tubing which are best suited for hydraulic operations.

With the addition of the new Series "K" and "L" to the Ortman-Miller major line of air and hydraulic cylinders, you can now rely on O-M for *all* of your low and medium pressure cylinder requirements. Both Series "K" and "L" are dimensionally interchangeable with other cylinders of a like type. Fabricated, precision steel mounts and accessories assure precise mounting.

Mail coupon today for complete details. All cylinders in Bulletins 115A and 116 have been dimensioned in accordance with NFPA recommendations for your convenience.

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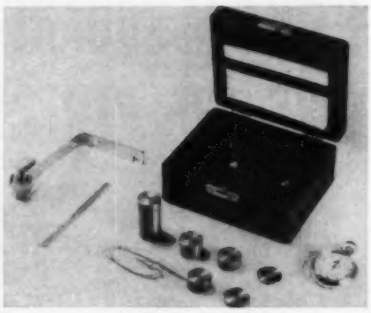
sa refinery of DX Sunray Oil Co. to perform on-line, closed-loop control of a new 85,000 barrel-per-day crude oil distillation unit. The RW-300 unit provides continuous and automatic control of the process by continually scanning 191 process instruments and adjusting 30 controller setpoints to maintain optimum efficiency. Variables such as temperatures, pressures, flow rates, and stream compositions are checked every 10 minutes and their readings are compared with predetermined limits stored in the computer's memory. Using this instrument data and a mathematical model of the process, the system exercises direct control over the distillation unit by automatically adjusting the appropriate controller setpoints. The control system also has an operator's console, analog input equipment, and three automatic logging typewriters which provide a printed log of all process variables bi-hourly, daily, and on demand. From the operator's console, the operator can push a button to request a demand log or to check instrument readings.

CONTINUITY CHECKERS, used during the assembly of transistorized digital computers, have been developed by Autonetics, Div., North American Aviation Inc. With this device, called Witness (Wire Installation Tester for Negating Errors by Sequencing and Stationization), the assembly is continually checked as each wire is installed.

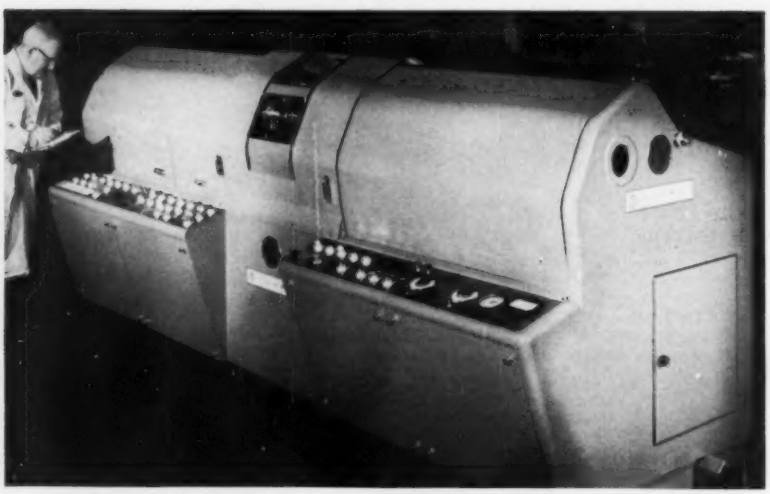
CONTRACT for an automatic control system in a large automated materials handling installation has been awarded to Electro Nuclear Systems Corp. by the U. S. Navy. Electro Nuclear will be responsible for the electronic controls in the conveyor system furnished by Alvey-Ferguson Co. Amount of the contract is $145,000. The conveyor system will serve warehouse areas at the Philadelphia Naval Supply Depot and will direct tote boxes to stock areas where orders are loaded into the boxes, sent to packing areas, and then to the shipping area. Sensing devices will read magnetic addresses which are on each box and route the boxes through the maze of conveyor lines.

SPOTLIGHTING PEOPLE

Samuel B. Korin appointed manager, manufacturing equipment development of International Business Machines Corp. . . . **Ralph S. Thompson** named vice president, manufacturing; **Robert H. Pierce** named vice president, engineering; and **Philip Garnick** named vice president, sales; all at Sigma Instruments Inc. . . . **F. J. Nardi** appointed manager, engineering administration and personnel development of the Industry Control Dept., General Electric Co. . . . **Earl H. King** named chief engineer of the Control Systems Div., Fostoria Corp. . . . **Dr. S. Roy Morrison** promoted to assistant director of the Research Center, Minneapolis-Honeywell Regulator Co. . . . **Z. E. Zilahy** named director of the Contract Engineering Div., Standard Tool & Mfg. Co. . . . **William J. Kerr** named vice president, development; and **Charles J. Lantz** named director of production; both at Yoder Co. . . . **C. O. Stettler** appointed chief engineer Transducer Div., Electro Products Laboratories. . . . **Dr. Earl R. Lind** joined the engineering department of the Systems Div., Electro-Mechanical Research Inc. as systems analyst. . . . **Damon Van Utt** appointed general manager of the Cramer Div., Giannini Controls Corp. . . . **B. Nevling Clune** named vice president and general manager of the Scale Div., Fairbanks, Morse & Co. . . . **Richard J. Newman** promoted to a newly-created position of director of planning and development for Daven Co. . . . **Sam E. Cumpston** appointed engineering manager for the Special Products Div., I-T-E



IN-LINE test kit for field testing industrial mass flowmeters has been developed by General Electric Co. Without removing the flowmeter from the line, the plug from the top of the housing is removed and a lever is introduced through it into the turbine. A cord attached to the lever is threaded over the pulley and tied to a weight. This weight exerts a steady pull on the turbine which in turn causes the flowmeter's gyro to precess. The gyro precession rate can then be measured with a stopwatch by noticing the reflections of a light or a reference mark on one of the two mirrors located on the housing of the gyro.



FRICTION welding machine has a capacity of 1¼ square inch weld area with 1020 steel; 1⅓ inch diameter solid bar; or tubing of 2 inch outer diameter. The machine, developed and to be marketed by American Machine & Foundry Co., has spindle speeds of 500 to 10,000 rpm, continuously variable. Pressure program is in two steps with maximum axial thrust of 20,000 pounds. There are two infinitely variable timers; 0-5 seconds and 2-90 seconds.

IT'S BOUND TO BE BETTER WITH A USS STEEL STRAPPING MACHINE.

"This machine saves us $2,000 a year"

"Our old strapping machine often cut magazine covers," says Mr. W. A. Akin, Vice President of Kalmbach Publishing Company, Milwaukee. "Orders were cancelled, circulation dropped, even the post office complained because the packages were unsafe and hard to open. So we switched to the new USS Model 12 Automatic Round Steel Strapping Machine. Our packages are safe and damage-free. Not only have complaints stopped, but we've saved $2,000 a year in labor costs and cut strapping costs by ⅔."

Kalmbach's completely automatic Model 12 uses 14- to 18½-gauge USS Round Steel Strapping. It binds about 24 packages per minute and handles various size packages without adjustment. It takes only 7½ sq. ft. of floor space and weighs only 1300 pounds.

Find out how the Model 12 can help your product cost less to handle, store, ship, and receive. See our new industrial film showing many possible applications for the Model 12. Send the coupon.

U. S. Steel Supply
Division of
United States Steel

USS
TRADEMARK

U. S. Steel Supply
U. S. Steel Corporation
208 South LaSalle Street
Chicago 4, Illinois

Please send me more information on:

☐ The USS Model 12 Automatic Round Steel Strapping Machine
☐ The new industrial film entitled, "Tie This"

Name_____

Company_____

Address_____

City_____ Zone____ State_____

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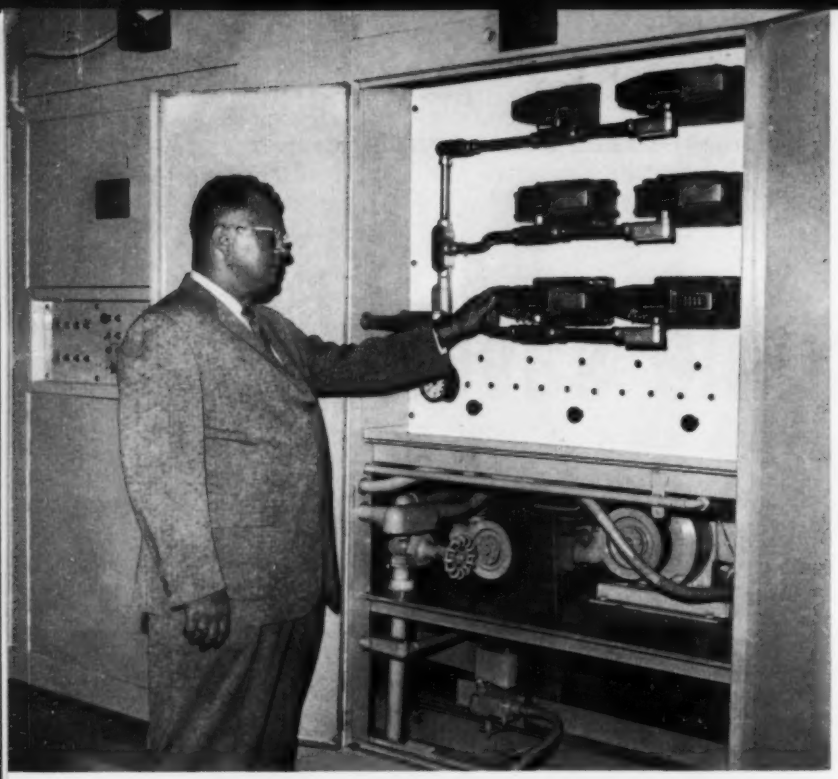
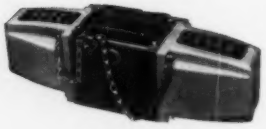


ALVEY USES THESE VICKERS COMPONENTS

DOUBLE PUMPS—Vickers double pumps provide power for multiple circuits from a central source, feature long life, minimum maintenance, quiet operation. Various combinations are available for deliveries from 1.0 to 34 at the head end and 1.0 to 55.0 gpm at the shaft end, pressures to 2000 psi.



DIRECTIONAL VALVES—Both single- and double-solenoid directional valves are used on the pallet loaders. Vickers exclusive *QEL solenoids are featured. Complete line of valves and controls accommodates flows to 440 gpm, pressures to 3000 psi.

*Quiet, Extended Life.

BALANCED VANE MOTORS—Durable construction, high operating efficiency, long life and low maintenance costs are features of Vickers vane motors. Broad line of fluid motors includes fixed and variable models with horsepower ratings to 350 hp.

CHECK AND RELIEF VALVES—A complete line of valves—relief, sequence and unloading, sequence and check, pressure reducing, unloading and relief valves—is available to meet every system need.

For details about components above and the entire Vickers line, write for Catalog 5001C. Vickers Incorporated, Division of Sperry Rand Corporation, Detroit 32, Michigan.

9958

VICKERS®

DIVISION OF SPERRY RAND CORPORATION

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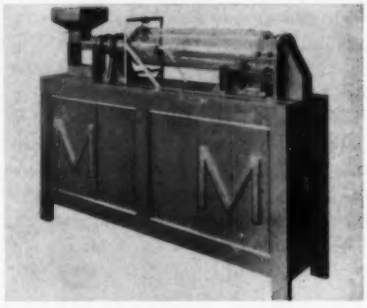
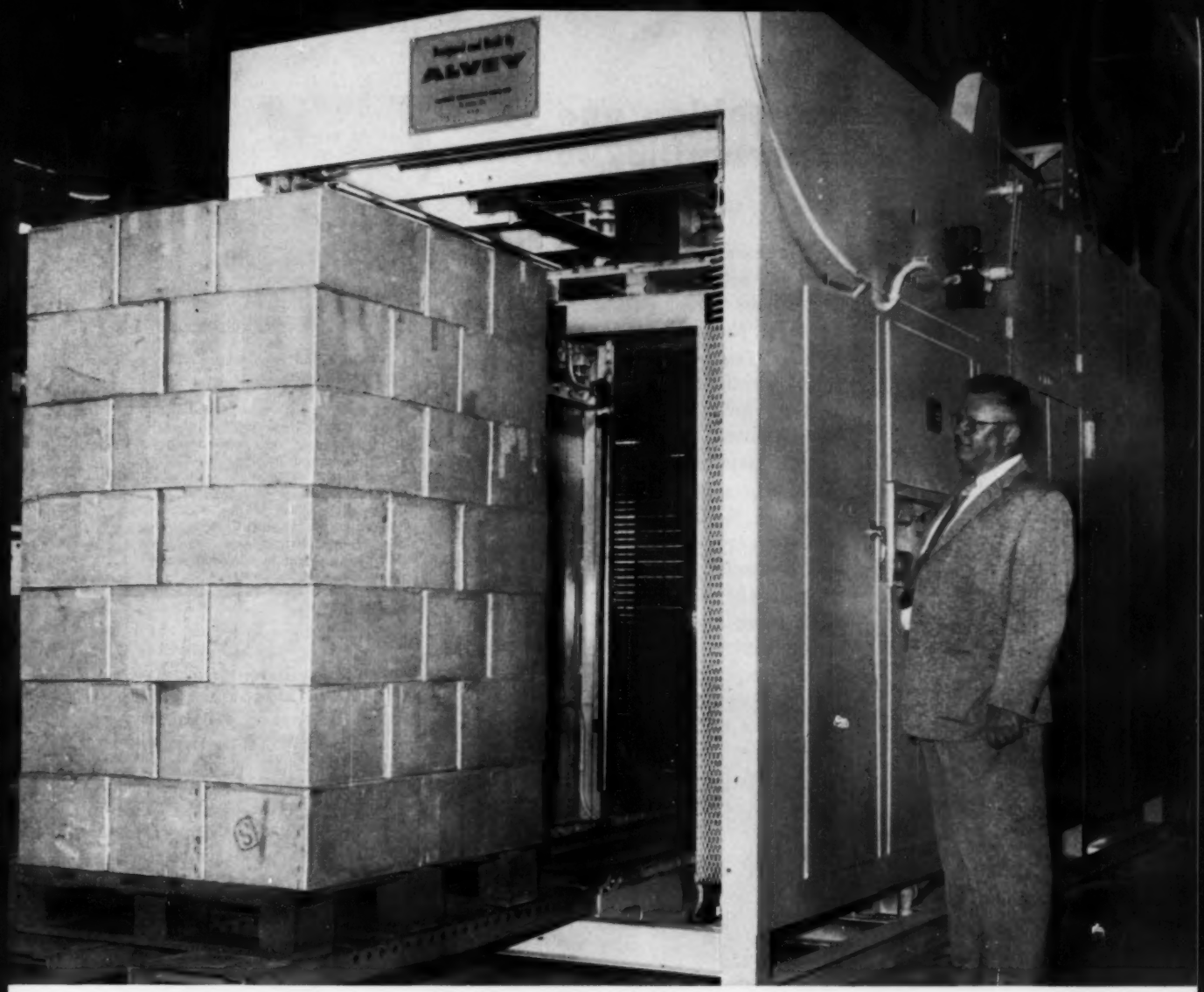
Circuit Breaker Co. . . . **Leroy Camel** elected vice president of Detrex Chemical Industries Inc. . . . **John L. Cramer** joined Electro Nuclear Systems Corp. as assistant to the president. . . . **R. A. Alexander** appointed to a newly-created position of manager, equipment design engineering, data communications and custom projects department of the Electronic Data Processing Div., Radio Corporation of America. . . . **Vincent A. Carter** appointed chief engineer of Champlain-Zapata Plastics Machinery Inc. . . . **Paul Jones** appointed division general manager of the Hastings Div., E. W. Bliss Co. . . . **Carl J. Bartoseki** named manager, paricode systems of North Electric Co. . . . **William A. Wildhack** appointed associate director of the National Bureau of Standards. . . . **Harold H. Brehouse** promoted to manager of the Vacuum Pumps and Components Dept., F. J. Stokes Corp. . . . **Leslie J. Carson** appointed director of engineering of Link-Belt Co. . . . **W. Gordon Brierley Jr.** appointed vice president for engineering and **Harold W. Hammerschmidt** named chief engineer, both at Automatic Control Co. . . . **W. Roderic Bliss** appointed assistant director of research at Selas Corporation of America. . . . **George D. Becker** named group vice presi-



ROTARY RETORT furnace with dual drive system is designed for carburizing and carbonitriding small parts, especially those requiring frequent turning. Tumbling is provided by one drive, and advance of parts through the furnace by a shuffle action is powered by the other drive. The shuffle action of the machine conveys the work into and through the retort where it is held from escaping ahead of time by a contoured retaining gate. The shuffle action discharge spreads and levels out the work and this discharge rate is controlled by an intermittent automatic interlocked timer which can be set for any interval and rate indicated for the case depth required. Furnace was developed by Varner Furnace Div., Joe Martin Co. Inc.



PETE HORN, VICE PRESIDENT—ENGINEERING, ALVEY CONVEYOR MFG. CO. SAYS:

"Hydraulics assure smooth, steady operation..."

". . . of the Alvey Automatic Pallet Loader. This equipment can, without stalling, palletize over 60 cases of products per minute, depending on case size. One Alvey Pallet Loader can be equipped to accommodate a wide variety of package sizes. Its electrically controlled hydraulic circuit assures smooth operation at fast speeds, thus helps prevent damage to fragile cartons and their expensive contents.

"The equipment must also be dependable and easy to service. We were able to meet these specifications, by working closely with Vickers engineers to select components matched precisely to our operating requirements.

"There are real advantages both for us at Alvey and for our customers because Vickers maintains an extensive field service organization and regional stocks of spare parts."

Are you aware of the "added benefits" available only to users of Vickers hydraulic equipment . . . single line application engineering . . . unmatched field service . . . regional repair and parts stocking . . . training for your personnel . . . worldwide interchangeability of parts?

Get the complete story from your Vickers application engineer, Vickers Incorporated, Division of Sperry Rand Corporation, Detroit 32, Michigan.

VICKERS®

DIVISION OF SPERRY RAND CORPORATION

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you may be overlooking one of your best opportunities to

REDUCE INDIRECT COSTS

In your search for new ways to reduce indirect costs, take a closer look at your fastening tools. These are most likely the busiest tools in your plant, in use hour after hour, day after day . . . and every use offers an opportunity to reduce indirect costs.

Apex fastening tools will help you cut costs every time you drive a screw or run down a nut or bolt. Each Apex tool is designed for use with a specific type and size of fastener. The tool fits the fastener properly, insuring smooth, firm assembly without harming the product or wearing down the tool.

Each Apex tool is carefully heat-treated in Apex' own metallurgical department, insuring the correct degree of toughness and resiliency for your specific application. And every Apex fastening tool is built for continuous, production line use, insuring longer service life with far less downtime for replacement.

IMPACT/POWER SOCKETS, EXTENSIONS, ADAPTERS, NUT SETTERS, UNIVERSAL WRENCHES, EXTENSION UNIVERSAL WRENCHES

There are over 7,000 types and sizes of Apex Nut Running and Screwdriving Tools, for use with all popular makes of air and electric power tools.

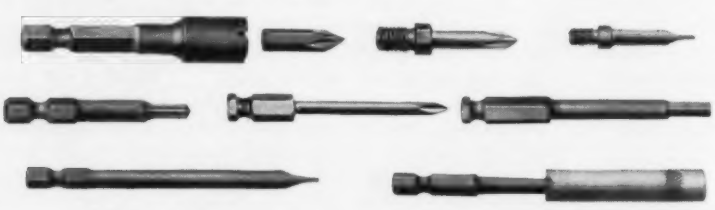
NUT RUNNING TOOLS
Catalog 30-A—¼", 5/32", 3/16", 7/32", 9/32" square drives, ¼", 5/16", 3/8", 7/16" hex drives.

Catalog 30-B—¾", 1", 1¼", 1½", 2½", 3½" square drives, 7/16", 9/16", ¾" hex drives.

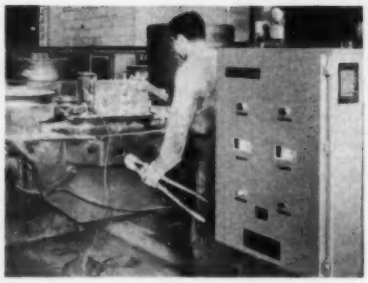
Catalog 30-D—Specials and Spline Drive.

SCREWDRIVING TOOLS
Catalog 30-C—Standard and Magnetic.

BIT HOLDERS, INSERT BITS, POWER BITS, FINDER SLEEVE ASSEMBLIES, HAND DRIVERS



APEX FASTENING TOOLS
SCREWDRIVING • NUT RUNNING • SPECIAL



FLAW DETECTION equipment, developed by Assembly Products Inc., is used to find difficult-to-detect flaws in moving wire, sheet, or tubing. In an installation at Copperweld Steel Co., butt welds in aluminum-covered steel wire are being detected at speeds in excess of 1000 fpm. Direct current excitation is used in an induction technique which picks up magnetic discontinuities in the steel and these alter the magnetic field surrounding the wire. The technique is sensitive to abrupt changes in magnetic properties, such as sudden changes in cross-section and changes in hardness or composition.

dent; and **A. L. Topp** elected vice president and named general manager of the Heating and Air Conditioning Div., Controls Company of America. . . . **P. J. Casella** elected president of Endicott Johnson Corp. . . . **Henry H. Maltbie** named vice president and general manager of the Specialty Valve, Trap & Controls Div., White Sewing Machine Corp. . . . **John C. Stick Jr.** appointed director of research of the instrument Div., Perkin-Elmer Corp. . . . **H. E. Jones** appointed senior vice president of Farrington Mfg. Co. . . . **Harry J. Bolwell** elected vice president of the Midland-Ross Corp. and general manager of its Surface Combustion Div. . . . **Walter Imboden** named chief engineer of the Textile Machine Works.

SPOTLIGHTING PLANTS

General Time Corp. has established an Electronic Systems Division as a step in expanding its development and production of time-based electronic equipment. The new division encompasses the former Incremag division which specialized in transistorized magnetic counting devices. . . . **Auerbach Electronics Corp.** has dropped the word electronics from its name and will now be known as Auerbach Corp. . . . **General Electric Co.** has completed a $500,000 polycarbonate manufac-

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your GAYLORD man is well-rounded in packaging

He has a quick, accurate answer to any question on corrugated packaging, from the design to the delivery of your product.

He makes it his business to understand every phase of packaging operations—box-making, printing, filling, closure, handling, shipping . . . the works. This way he makes sure your Gaylord containers perform most effectively and economically

Ask him one question or a dozen; he's as near as your telephone, right now.

CROWN ZELLERBACH CORPORATION
GAYLORD CONTAINER DIVISION

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HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

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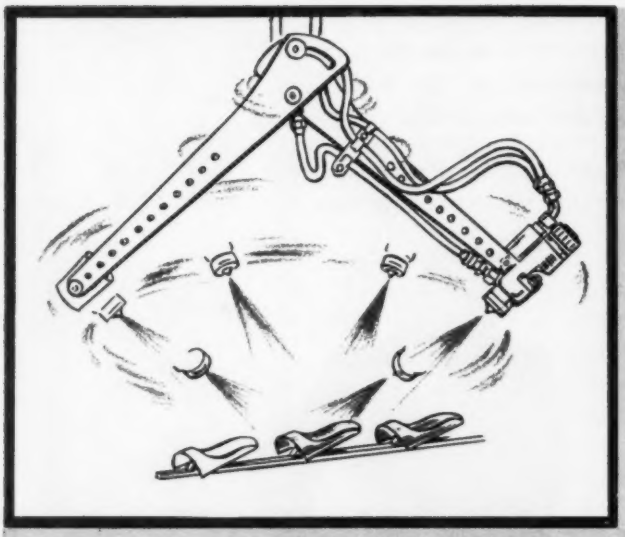
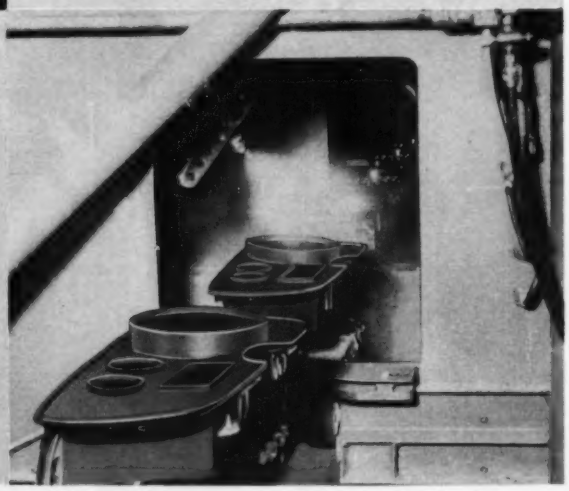
Cut Painting Labor and Overhead with a . . . *FIN-E-CO* ROTOMATIC COATER



Quality finishing of metals or plastics at high production rates are obtained without highly skilled or specially trained personnel. Parts are coated evenly on all surfaces . . . even multicontoured shapes that formerly could not have been coated satisfactorily by any other method. Production rates can run as high as 30,000 per hour when used in a Fin-E-Co "Ride-the-Rod" machine. Rejects are practically eliminated, because the Rotomatic does every part exactly the same. Put a Rotomatic in your planning. You can buy it on many different terms.

Send for our new four-page brochure on the Rotomatic Coater.

Amos Molded Plastics in Edinburg, Indiana, reports a production increase of 166% in base and top-coating a vacuum-metallized automobile instrument cluster. According to Amos, quality of Rotomatic Coating is consistent and uniform, even though the part is an extremely difficult design to cover. A progressive, high-volume producer of quality products, Amos is one of many companies that have discovered the extreme versatility of Fin-E-Co automatic machinery. Fin-E-Co "Ride-the-Rod" machines equipped with Rotomatic Coaters have been proven in field use.



Fin-E-Co has become the leader in decorating equipment, because it has stayed a jump ahead. Take advantage of years of decorating experience . . . automate with Fin-E-Co.

FINISH ENGINEERING CO., INC.

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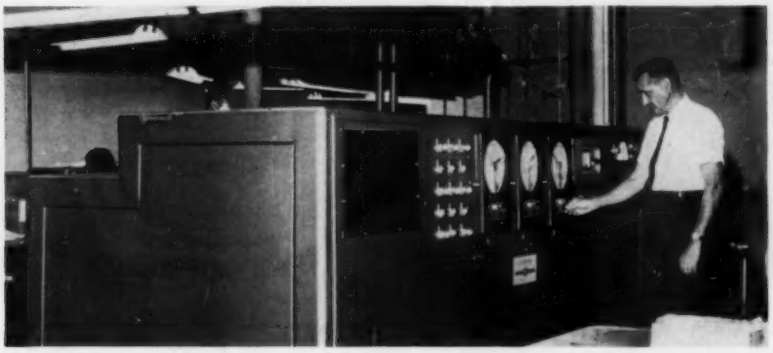
turing engineering laboratory at Mount Vernon, Ind. This facility will increase developmental work on Lexan copolymers, elastomers, and film and will permit conversion of the present pilot plant at Pittsfield, Mass. to full time product development activity. . . . **Corning Glass Works** has started construction on a 120,000 sq ft electronic components plant in Raleigh, N. C. The new plant will produce fixed glass-dielectric capacitors. . . . **Bendix Corp.** has reorganized its operations in South Bend, Ind., into two separate divisions, to be called the Bendix Products Aerospace Division and the Bendix Products Automotive Division. The divisional realignment will separate the military and commercial operations. . . . **Dow Chemical Co.** is constructing a building for the chemical physics research laboratory. The structure will include 20 major laboratory and development areas, with office and service space. Functions of the laboratory include the development, construction, and installation of automatic continuous analyzers for production plants. . . . **Norden, Div., United Aircraft Corp.**, has moved its Ketay department to a new plant in Norwalk, Conn. This move will consolidate employees from five facilities into a 350,000 sq ft plant. . . . **Electronic Memories Inc.** is the name of a new company formed to develop, design, and manufacture ferrite memory cores and core memory systems. The company will have its headquarters in Los Angeles. . . . **Ultrasonics Div., Automation Industries Inc.** has moved to a new plant in Torrance, Calif. The plant occupies an area of 45,000 sq ft. . . . **Watlow Electric Mfg. Co.**, manufacturer of electrical industrial heating units, has moved to a larger plant and office building in St. Louis. New production machinery has also been installed in the plant. . . . **Presstite Div., American-Marietta Co.** will start construction on a plant in Georgetown, Ontario which will produce sealants, insulation, and caulking compounds, and other industrial chemical products. . . . **James Cunningham, Son & Co. Inc.**, manufacturer of crossbar switches, has moved to a new plant in Honeoye Falls, N. Y. . . . **Dynasonics Corp.** is the new name of the corporation formerly known as Narda Ultrasonics Corp. The name was changed to better describe the company's program in the field of electroacoustics. . . . **Inductotherm Corp.**, manufacturer of high frequency induction melting and heating equipment, has moved to a new plant in Rancocas, N. J. The plant has 35,000 sq ft of manufacturing and office space. . . . **Permutit Co., Div., Pfaudler Permutit Inc.** is planning to move to new headquarters in Paramus, N. J. . . . **Roto American Corp.** has acquired Miller & Van Winkle Co. and will operate it as a subsidiary. Miller & Van Winkle manufactures general purpose plastic molding machinery. . . . **Marbon Chemical**



CONVEYORIZED vacuum furnace, which alloys diodes, operates automatically except for loading and unloading. Boats containing diodes are placed on an external conveyor which automatically injects them into a vacuum-lock inlet. From here work is conveyed by belt through the heat zone where it undergoes processing temperatures up to 1000C and is then returned to atmosphere through the vacuum-lock outlet. Production rate is 34 boats per hour, with 250 to 300 diodes per boat. Set temperatures are maintained within ±1C by means of proportional control instruments which govern three heat zones within the furnace. Control is by a three-mode system: Rate, reset, and proportional band. C. I. Hayes Inc. built the unit for General Instrument Corp.

More cycles!
No stretch!
Less punch wear!

New "Peerless" Fibre control tape wears 30 times longer than paper; costs 1/6th that of polyester film!

Need a tough tape that will take machine shop handling? A durable tape for repeat operations? Check the savings in new "Peerless" control tape. It's made of National Vulcanized Fibre, a cellulose plastic—the only tape of its kind!

Compare "Peerless" tape's long, cost-cutting cycle life:

Speed (codes per minute)	Paper Tape (cycles)	"Peerless" (cycles)
1200	100 to 115	3,000 & over
620	1200 to 1900	30,000 & over

And check "Peerless" tape's amazing properties! It's extra tough, flexible, with high tensile and bending strength. It has high opacity, excellent abrasion resistance and is easily punched. Thicknesses: .0043" and .005"—heavier thicknesses available.

"Peerless" does not stretch in use. Precision-punched holes remain true. In addition, "Peerless" is *plastic-smooth* and impurity-free; friction and wear on punching and feeding equipment are cut to the minimum.

"Peerless" tape is available in any width. It is already proving its superior economies in tape life and cost on major automatic programming equipment in industry, government and business. Colors: Red, Gray, Blue, Black. Investigate now. Write for Free test sample and complete information. Dept. UU-12.

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BY THE TON Largest self-unloading ship on the Great Lakes—the 666′ *Adam E. Cornelius*—unloads coal, limestone, sulphur and other bulk cargo at speeds up to 5000 tons per hour. Unloading dusty cargo at conveyor speeds of 560 fpm calls for a large variety of ultra-dependable electrical control equipment. The *Cornelius'* entire material handling system—including hold conveyor belts, elevator bucket conveyor and a 250′ deck-mounted boom—is Cutler-Hammer controlled from a single master pushbutton console. You'll find Cutler-Hammer aboard all types of ships, from nuclear submarines to luxury liners.

BY THE TEASPOON Fragile, tiny (.040 in. square, .0015 in. thick) germanium and silicon crystals used in transistor production are gaged and classified according to thickness by this automatic gaging system. Because of their light weight and tendency to cohere due to static charge, the automatic handling of these dice is a sticky problem.

Cutler-Hammer automatic gaging components and engineering know how permit similar electronic equipment to detect out of tolerance trends in machine tool output. Feedback control based on automatic gaging closes the loop and eliminates scrap.

BY THE TRAYFUL "How can you materially increase the efficiency of a controlled conveyor system without increasing conveyor speed or adding to the cost of conveyor equipment?" A Cutler-Hammer engineer's ingenuity and a roller skate wheel solved this "impossible" problem. Originally, a curved metal bar was swung between trays, on signal from a supervisor, to divert the trays from accumulation area to individual sorters. The diverter required a full tray's length for the arm to swing back and forth. Cutler-Hammer's "roller skate system" eliminated the swinging arm and doubled the capacity of the system.

CONTROL

Coal, crystals, paper... whatever your automation problem may be...

Here's why you should call the control expert early in your automation planning

IF YOU HAVE A MATERIAL HANDLING problem, the chances are it is a *control* problem. It is in the techniques of control that most advancements have been and will continue to be made in material handling systems.

Controls, as such, usually represent a minor share of total system costs—even with the sophisticated memory devices often used in modern, automated material handling systems.

Why then, should you turn to the control specialist for the solution to your problem? Because *control is the heart and mind of a material handling system.* Regardless of who the prime contractor for your installation may be, responsibility for making the system function invariably falls on the control engineer.

The control specialist—best qualified to insure compatibility of the complete electro-mechanical system—must be called in early in planning if you're going to get the best possible system. Your Cutler-Hammer expert will assume responsibility for all controls; or, responsibility for the entire system.

The installations illustrated typify a variety of material handling problems Cutler-Hammer engineers have solved. Chances are they've solved many problems similar to yours. Why not call your local Cutler-Hammer office? You have everything to gain.

Opportunities available for qualified engineers.

CONTROL

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International C. A. Associates: Cutler-Hammer Canada, Ltd.; Cutler-Hammer Mexicana, S. A.

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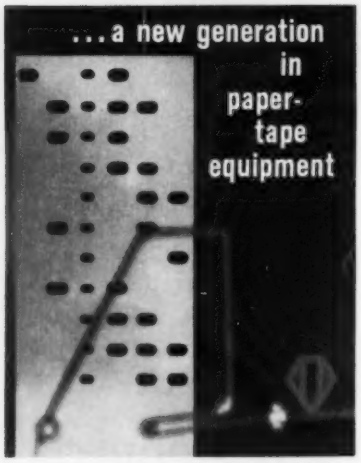
omni-data

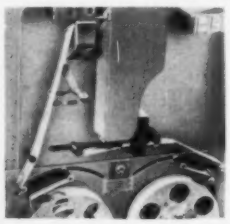


• High-speed electrostatic paper-tape recorder replaces mechanical punches

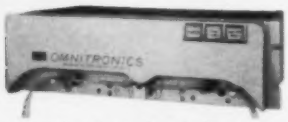
• Reflected-light reader accommodates all tape types

OMNI-DATA, a new line based on non-mechanical reading and recording, brings a new order of reliability, speed, and operating life to the application of coded paper tape.

OMNI-DATA combines two exclusive Omnitronics advances: Visible recorded code presentation, rather than punched holes in the tape, and chopped-reflected-light reading, both resulting in new levels of performance.



Visible recorded data issues from OMNI-DATA recorder at speeds up to 600 characters a second. Even higher recording and reading speeds are possible.



Omnitronics Photoelectric Tape Reader reads any kind of tape interchangeably without adjustment.

Learn the exciting details about OMNI-DATA recorders, readers, and reelers. Write for full information.

OMNITRONICS, INC.

Subsidiary of Borg-Warner Corporation

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511 N. Broad St.
Philadelphia 23, Pa.

See us in Booth B-16, Eastern Joint Computer Conf., Dec. 12-14, Wash., D.C.

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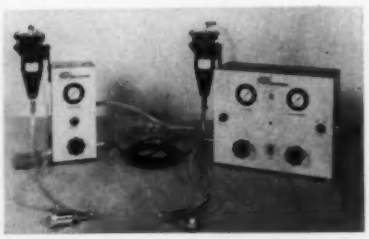

AUTOMATIC paste solder applicator is capable of making two deposits of paste solders or paste brazing alloys simultaneously. Method developed by Fusion Engineering automatically applies solder or braze alloy and flux (in paste form) to the parts to be soldered or brazed while the parts are on the soldering line. The twin applicator uses an electrical circuit and one air circuit in both units. Each unit has an individual applicator gun and a paste storage tank.

Div., Borg-Warner Corp. has purchased a plant site at Grangemouth, near Edinburgh, Scotland and will construct a plant to produce Cycolac brand polymers and other synthetic resins. . . . **C-E-I-R Inc.** has opened an analytical services and data processing office in Dallas. The unit will provide systems development, model building, linear programming, and other special services, as well as data processing. . . . **Hi-Seal Inc.** has started manufacture of teflon press locking terminals in a plant in Mamaroneck, N. Y. . . . **IMC Magnetics Corp.** has established a special products engineering group at its western division in Maywood, Calif. The group will be responsible for advanced electromagnetic and electromechanical planning.

MEETINGS AND EVENTS

Dec. 6-7—

American Society of Tool and Manufacturing Engineers. Seminar on electric machining and forming (electro metal removal) to be held Statler Hilton Hotel, Hartford. Details are available from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Dec. 7-8—

Society of the Plastics Industry Inc. Ninth Plastic Film, Sheeting, and Coated Fabrics Conference to be held at the Pierre Hotel, New

NEW Stromberg-Carlson® lightweight telephone handsets

. . . for a wide range of applications such as dictating systems, mobile radio, carrier and microwave.

These new lightweight Stromberg-Carlson handsets, No. 33 and No. 35, incorporate push-to-talk switches, broadening the range of their applications. Both feature high-gain, high-efficiency transmitter and receiver.

The No. 33 model is furnished with a bar-type switch, located on the underside of the handle.

The No. 35 handset is furnished with a button switch on the side of the handle near the receiver end. Also available with both button and bar switches.

For technical details and ordering information, contact any of these sales offices: Atlanta—750 Ponce de Leon Place, N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Ave.; San Francisco—1805 Rollins Rd.

GENERAL DYNAMICS TELECOMMUNICATION

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York. Further information available from society headquarters, 250 Park Ave., New York 17, N. Y.

Dec. 11-13—

Metal Joining Symposium. Sponsored by Pennsylvania State University. Symposium will deal with the fields of soldering, brazing, and welding procedures and materials. Additional information available from the Conference Center, Pennsylvania State University, University Park, Pa.

Dec. 12-14—

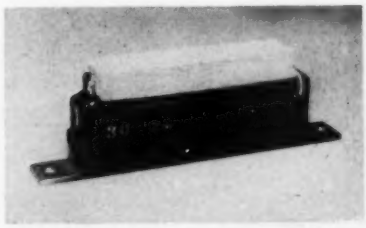
Eastern Joint Computer Conference. Cosponsored by the Institute of Radio Engineers, American Institute of Electrical Engineers, and the Association for Computing Machinery. To be held at the Sheraton-Park Hotel, Washington. More details available from EJCC committee, 1111 Connecticut Ave. N. W., Washington 6, D. C.

Jan. 8-12—

Society of Automotive Engineers Inc., 1962 Automotive Engineering Congress and Exposition to be held at Cobo Hall, Detroit. Additional information available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Jan. 9-11—

National Symposium on Reliability and Quality Control. Cosponsored by American Institute of Electrical Engineers, American Society for Quality Control, Institute of Radio Engineers, and the Electronic Industries Association. To be held Statler Hilton Hotel,



HEATING ELEMENT has conductive and insulated coatings sprayed-on that are 0.015 inch thick combined. The heating element, designed by Electrofilm Inc., has an internal temperature control which maintains environment at 92C ±1C with watt density sufficient to provide initial temperature rise from as low as −45C to +92C in less than 15 minutes. The heating elements can be applied to flat, cubicle, or contoured surfaces of any kind or size.

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COMPACT DESIGN • FAST RESPONSE
POSITIVE REMOTE CONTROL PERFORMANCE

Incorporating advanced design principles proved through years of service, the MAXITORQ Electric Clutch is well adapted to all types of machine drives. Simple in design . . . built to machine tool standards . . . requires no adjustments, can be used either as a clutch or brake. Disc separators not only separate discs, but also break up residual magnetism and result in extremely fast, positive action with no drag or heating in neutral. There are few moving parts. Electrical operating unit remains stationary — hence, no troublesome slip rings, brushes, or difficult wiring problems. Operation is on standard 100 V d.c. Other voltages on special order.

FAST ACTING
POSITIVE ENGAGEMENT and RELEASE
REMOTE CONTROL
COMPACT DESIGN
SELF ADJUSTING
NO TROUBLESOME WIRING

If you have a clutch or brake application where you are looking for NEW and IMPROVED performance, we invite you to bring the problem to us. Phone, wire or write Dept. AT for Bulletin No. 90.

THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONN.

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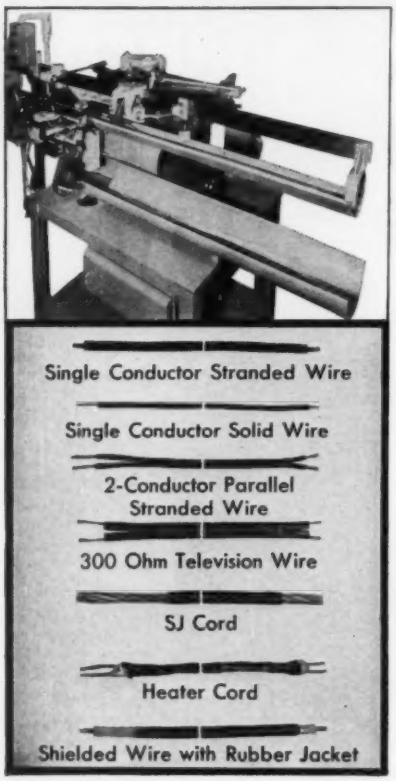
Another Time and Labor Saver

for finishing wire leads

with ARTOS AUTOMATIC CS-6



A new collecting device is now available for use on the popular Artos CS-6 wire-measuring, cutting and stripping machine. Illustration shows the new collecting trough (AE-478). Upper trough collects wire leads up to 60 inches long, then empties into the lower trough after wire has been cut, thus saving operator time.

Production speeds of 3000 finished wire leads per hour up to 15 inches long. Maximum cutting length is 194 inches . . . stripping up to 2 inches at one or both ends. Artos also makes machines that measure, cut, strip and *attach terminals* automatically at one or both ends.

Operated by unskilled labor. Errors and work spoilage, due to human element, are eliminated. Machines are easily set up and adjusted for different lengths of wire and stripping.

Proved performance. Time-consuming hand stripping jobs which once were a bottleneck in many plants are gone forever. As a result, Artos automatic wire strippers are paying their way in the mass production of television and radio sets, electrical appliances, motor controls and instruments of all kinds.

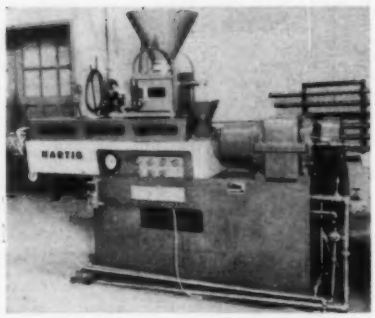
If you need big capacity on wire lead finishing, WRITE for descriptive Artos Bulletin No. 36. Engineering consultation without obligation.

AGENTS THROUGHOUT THE WORLD

World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.

2785 South 28th Street • Milwaukee 46, Wisconsin



TEFLON-COATED screw, used in a feeder developed by Vibra Screw Feeders Inc., accurately meters corrosive zinc stearate into this plastic extrusion press. The stearate serves as a lubricant. It is metered in ounces per hour simultaneously with 150 pounds per hour of polystyrene pellets.

Washington. More information available from IRE, 1 East 79th St., New York 21, N. Y.

Jan. 15-17—

Symposium on Optical Character Recognition. Cosponsored by the Information Systems Branch of the Office of Naval Research and the Research Information Center of the National Bureau of Standards. To be held in the Department of the Interior Auditorium, Washington. Additional information available from Miss Josephine Leno, Code 430A, Office of Naval Research, Washington 25, D. C.

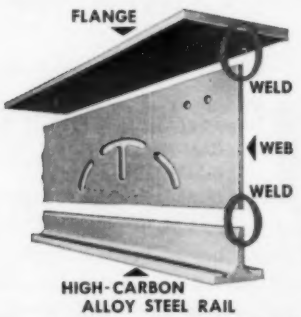
Jan. 22-25—

Plant Engineering & Maintenance Show. Exhibition and conference will be held at Convention Hall, Philadelphia. More details available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

TARCA TRACK

TARCA TRACK TRADE MARK

Introducing a *Superior* OVERHEAD TRACK for *AUTOMATIC HANDLING*



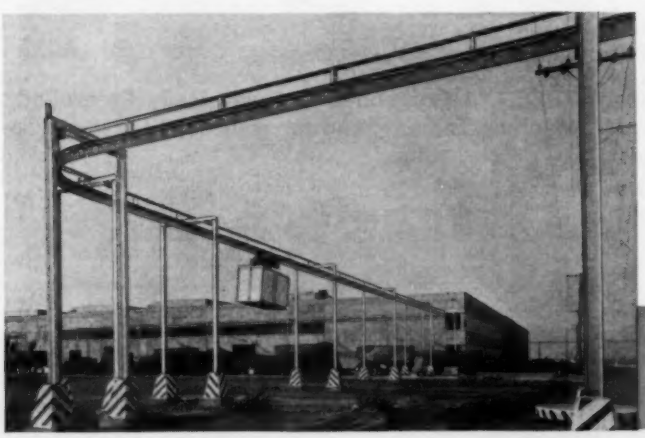
Here's an entirely new track that will withstand heavy, swinging, and impact loads — provide a smooth trouble-free overhead road for materials movement — assure extra years of service over ordinary tracks.

Tarca Track was perfected by Cleveland Tramrail after extensive research and testing. It is different from all other overhead tracks.

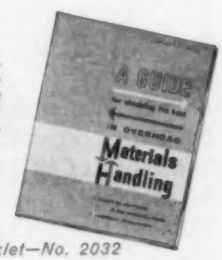
Tarca Track parts are proportioned to provide a perfectly balanced design to suit all load requirements. They are combined into one rugged section by automatically controlled welding. All welds are continuous to assure maximum rigidity.

Erection is easier, faster because Tarca Tracks are straight and accurate. Need of shimming and other time-consuming work is eliminated. New support fittings speed erection and facilitate track alignment.

Integrally Welded TARCA TRACKS are composed of a specially-rolled high-carbon steel rail with raised wearing treads, and a steel flange and web, welded into an integral one-piece section. Wide range of sizes, for loads from 500 lbs. to 20 tons.



Cleveland Tramrail automatic materials handling systems operate between two or more points on the same or different elevations, or between buildings, as illustrated. One system serves 126 stations.

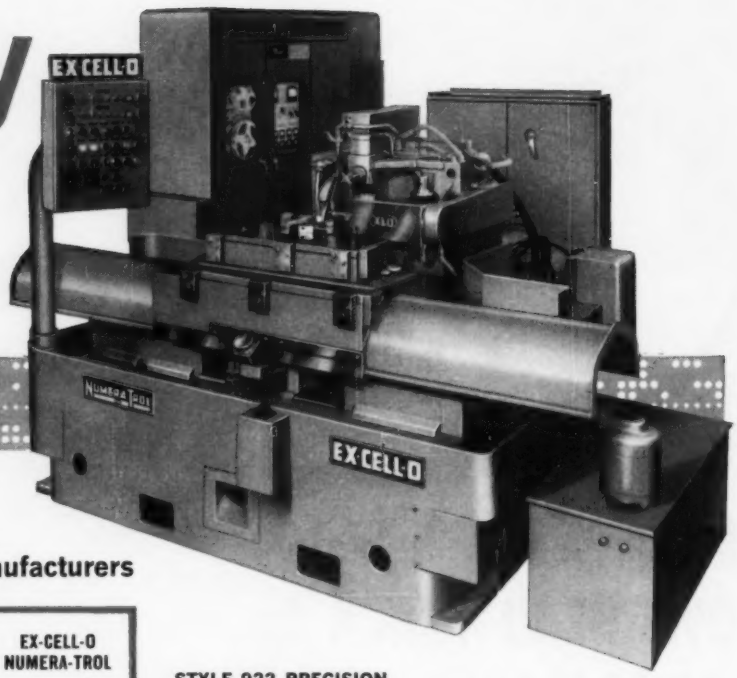


Ask for this Helpful Booklet—No. 2032

CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO
1366 East 290th Street, Wickliffe, Ohio

Circle 672 on Reply Card

a study in time



How Ex-Cell-O Numera-Trol Cuts Costs for Three Modern Manufacturers

Part: TEMPLETS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	128 hrs.	16 hrs.
Grinding per/piece	60 hrs.	6 hrs.
TIME SAVED	166 HOURS	

Part: FUEL CONTROL CAMS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	150 hrs.	40 hrs.
Machining per/piece	80 hrs.	7.5 hrs.
TIME SAVED	182.5 HOURS	

Part: STEAM TURBINE BUCKETS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	144 hrs.	24 hrs.
Machining per/piece	90 hrs.	12 hrs.
TIME SAVED	198 HOURS	

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Slides are controllable to .000025". Grinding unit is interchangeable with boring and turning unit.

PRECISION CAM-MILLING MACHINE
Slashes lead time in producing drum-type cams.

PRECISION PROFILING MACHINE
Performs intricate and accurate milling and grinding of 3-dimensional forms.

Are you faced with tough prototypes or production parts that "can't" be produced economically? See your Ex-Cell-O Representative, or write direct for details on how you can apply Ex-Cell-O's Numera-Trol system of tape-controlled precision machine tools to do more jobs, faster and more accurately!

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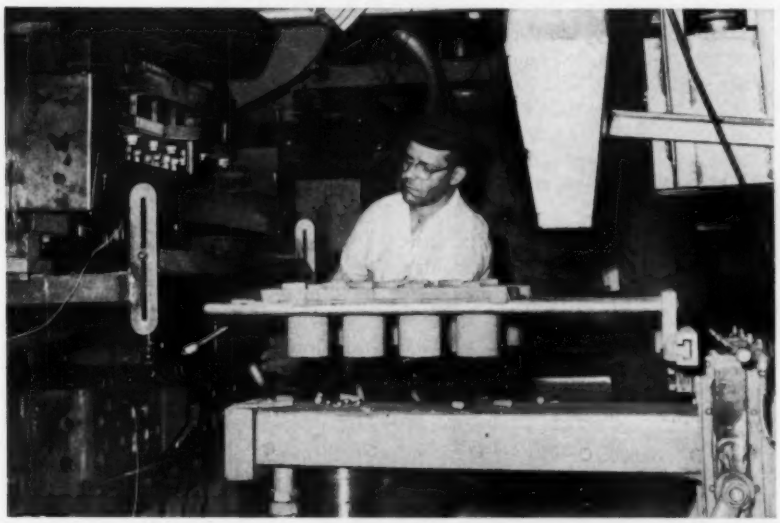
Machinery Division

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

Circle 673 on Reply Card

By LEE D. MILLER, Associate Editor



New core making machine at Ford's Cleveland foundry is an important part of the developments which have made possible the production of lightweight cast iron blocks. Cores for the new blocks are made with a minimum of distortion by using heated core boxes fixed in the machine. Core sand with a new plastic binder is automatically placed in the core box and given a quick cure while still in the core maker.

Engineer Engine Manufacture

IT HAS been acknowledged that manufacturing engineering offers beneficial effects for any manufactured product. Since the engine or power plant is about as basic a component as any manufactured for automobiles, it isn't surprising to find manufacturing engineers have been in action for the engine plants of autodom. Of course combining of blocks and heads can give simply blockheads, but the techniques and equipment being used in those plants indicate they don't have very many blockheads doing the manufacturing engineering.

M E to The Rescue

For example, Ford Motor Co. has recently revamped facilities in their Cleveland complex that produces engines. Part of the complex is a foundry that casts engine blocks, heads, manifolds, and other components. New materials and techniques have been introduced to produce a new 221 cubic inch V-8 which is lighter but considerably more powerful than the same size Ford engine of 30 years ago. The new engine has 145 horsepower, compared with 65 horsepower for the 1932 version.

Design specifications for the new engine are met by thinner walls in the castings since the new techniques enable the foundry to produce walls of a more uniform thickness than previously possible. The weight of the cast part is cut by reducing extra wall thickness required to compensate for variations in core and mold dimensions and possible core shifting in earlier methods.

Techniques in the foundry were changed in three important aspects to make the lightweight design specs realistic: 1. A new plastic binder was adopted in the core sand mixture. 2. New equipment was installed to make cores in pre-heated core boxes that give the core an initial cure in a few seconds. 3. Squeeze pressures were increased about 20 per cent in the molding machines producing the cope and drag halves of the mold.

One of the new core making machines is partially shown in the lead photograph. In its operation, a core box fixed in the machine is automatically filled with the core sand mixture. The core box is heated so that the curing of the core is rapidly begun in the machine. At the end of the cycle, ejector pins separate the core from the core box and deposit it on unloading fingers that carry it out to the operator for unloading.

Some curing of the core actually continues as it cools. But the heat curing in the core box fixes the core dimensionally so that distortions are avoided that were formerly the result of handling and baking operations on green cores. The improved accuracy of the cores and the denser molds produced by increased molding pressure led to significant improvements in casting accuracy.

C. H. Patterson, Ford vice president—Power Train and Metal Stamping Group, points out that Ford has built and evaluated many lightweight engine blocks of various light-metal alloys, and that research in this area is continuing. However, the new foundry technique reduces the weight of the engine over previous models while still permitting the economy and natural lubrication advantages of cast iron.

In considering this development it appears that manufacturing engineering talent deserves some credit for maintaining the product designer's freedom to use cast iron (Manufacturing Engineering to the Rescue). This example also illustrates why co-ordination between the design engineering and the manufacturing engineering functions must start early in the life of a new product project. Improvement of techniques for cast iron parts would have had less impetus and less importance to this product if process modifications had been considered impossible and the design had been arbitrarily assigned to light-metal alloys.

Check It Better Too

Another attack on the problem of ensuring that block sections have desired thicknesses was made some time ago by the General Motors Process Development Staff. They developed a non-destructive ultrasonic tester that can measure cylinder wall thickness in thousandths of an inch. The device uses the principle of ultrasonic resonance and can be used where only one side of a section is accessible.

In essence, the equipment provides the means to vibrate a crystal at different frequencies in contact with the cylinder wall to be measured. The resonant frequency will vary with the wall's thickness and is thus an indication of that thickness. Using a 14-inch cathode-ray tube, cylinder wall thickness is indicated by a single vertical step in a bright horizontal line. The readout system can also trigger a red light when cylinder wall thickness is below standard.

The cylinder wall thickness gage was developed at the request of GM's automotive divisions for improved quality control of engine castings. Like the Ford developments it represents an advance in tools and techniques that provide tighter control over cast iron workpieces and thereby ultimately give the user more for his money.

Farther Down The Path

Castings from the foundry are machined and assembled into the new 221 cubic inch V-8 by another plant in the Ford Cleveland complex. The urge to do it better extended on down the path to that plant as well. Known as Engine Plant One, it was the object of a year-long multimillion dollar renovation program. The plant had been producing 292 cubic inch V-8's, but it was shut down except for some small parts operations. Assembly and machining lines were deactivated and 335 machines were rebuilt or replaced.

This major remodeling of the plant equipment was a job requiring a big piece of calendar. In June, 1960, the machinery vendors were invited to the plant. After conferring with Ford engineers, they formulated plans to rebuild machines, some of which had been in service since the plant started operations nine years earlier. The machines were disassembled and in September, 1960, shipments to vendors' plants began. Purchase orders for new machines were also issued.

Return of rebuilt machines began last winter, and by March, 1961, the engine plant was receiving 20 machines per week. On June 1, production of 650 test and development engines was started. During final phases of the test program, product design engineers responsible for all components of the new engine came to the plant to review manufacturing operations. Each engineer had to confirm that his particular part was being produced to specifications. Regular engine production then began on August 1.

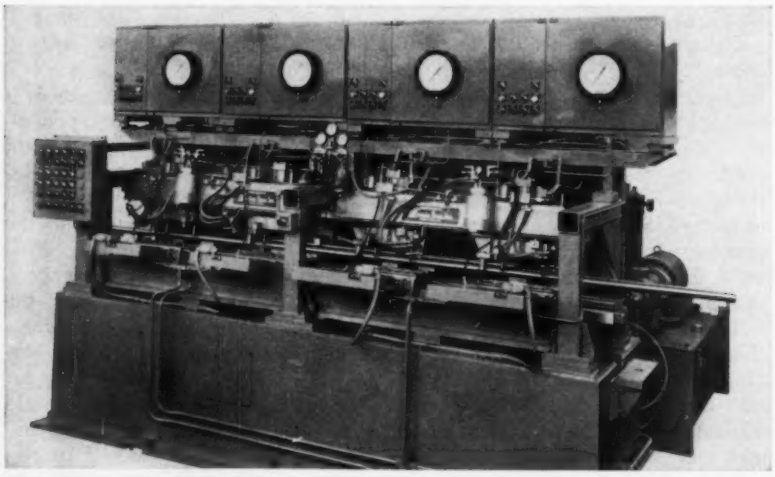
The change in foundry techniques was accompanied by new conditions on the machining lines too. Basic concepts in machining of components were not changed much, but horsepower was increased on many machining heads. The increased accuracy of castings has decreased the amount of metal to be removed, and development of new speed, feed, and tool specs is still in process.

Acid Tests with Air

Moments of truth for all manufacturing operations are those points in time when manufactured units must pass the acid tests of inspection for acceptance or rejection. An automatic technique along the assembly line at Ford Engine Plant One is an air test of a completed engine for potential oil leaks. Air under seven pounds pressure is pumped into assembled engines. If no air escapes, the test shows that the front and rear crankshaft oil seals, rocker arm cover gaskets, intake seals, and oil pan gaskets are properly installed.

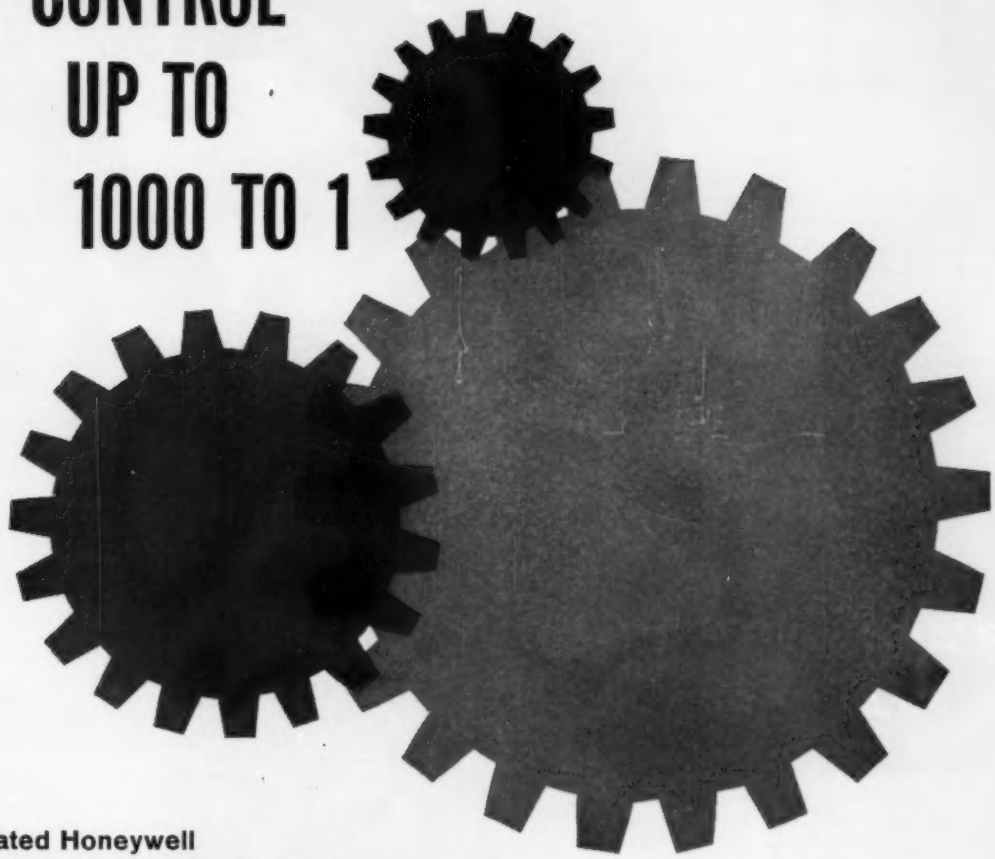
For another plant, Turner Bros. Inc. developed a transfer type machine to test cylinder heads for either 4 or 6-cylinder engines. The workpiece is hydraulically clamped and a measured amount of air under pressure is injected into the head being tested. If the head is airtight, the equipment will illuminate a green light and actuate a paint marking system. If the head is not airtight, a red light will appear.

Importance of such tests in an engine plant was dramatized by C. G. Bauer speaking as director of quality control for Chrysler Corp. He reported, "The direct-labor cost of installing a certain small engine part is two cents. And fortunately, an improper installation of this kind is so rare as to be almost non-existent. When it does occur, it can be corrected at the engine plant for $2, or later at the assembly plant for $18. But if this engine part has to be replaced outside one of our plants through dealer warranty, the cost to us rises to $100." It seems that a prospective saving of $99.98 per unit may justify considerable manufacturing engineering activity in the future too.

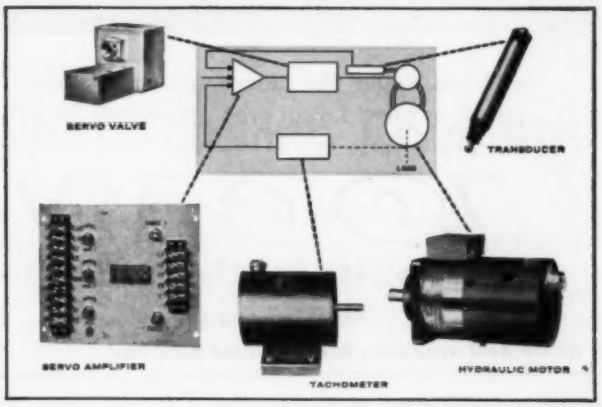


Transfer type machine has been built by Turner Bros. Inc. to test either 4 or 6-cylinder engine heads under air pressure. Acceptable parts are marked with paint and the machine automatically shuts down if five tests in a row indicate defective workpieces.

SPEED CONTROL UP TO 1000 TO 1



Integrated Honeywell speed servo control systems assure smooth, steady operation!



A matched Honeywell Speed Control system can assure you of precision control at any speed. Based on the "building block" concept, a Honeywell system is easily adaptable to a wide range of industrial uses. The basic components of a Honeywell Speed Control system are proportional servo amplifiers, transducers and electro-hydraulic servo valves. Each Honeywell component has been compactly designed and ruggedly built to insure long-life and continuous reliability.

In addition to their sturdy construction Honeywell Speed Control systems offer negligible droop under load fluctuations and smooth, steady low-speed operation.

For details on any or all of Honeywell's Speed Control systems, write Honeywell, Dept. 12-61, Minneapolis 8, Minnesota.

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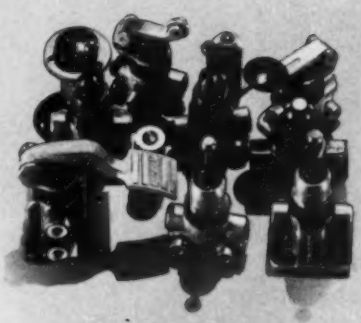
why does Logan stock so many *AIR AND HYDRAULIC VALVES?*



Logan offers a wide selection in size and design of both air and hydraulic valves to meet a demand that has steadily grown over the years.

This effort to be of service beyond the design and manufacture of air and hydraulic equipment has been a vital part of the Logan program since the company was founded.

If you would like more information about valves, or other Logan products, merely fill in the coupon below.

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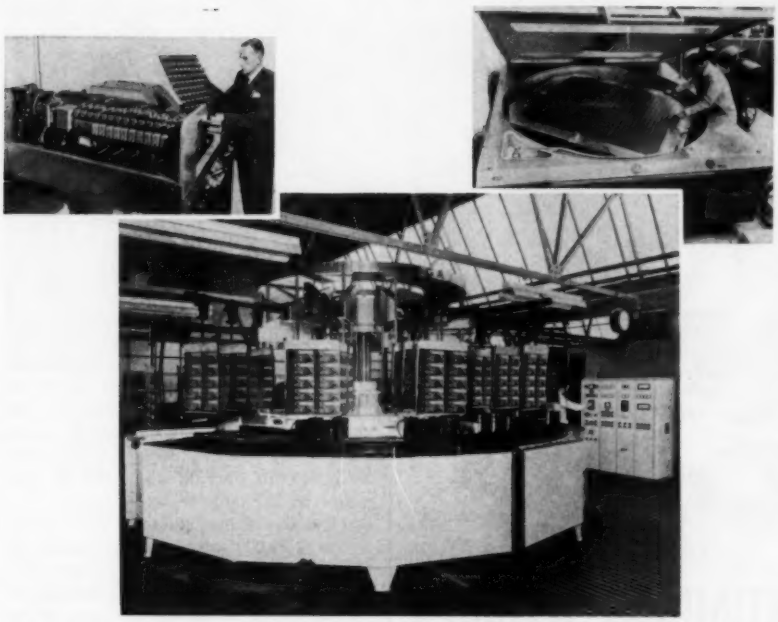


Special automatic equipment is used in the photo-etching process for making printed circuit boards and components. "Step and repeat" camera (upper left) can reproduce a negative of a small part as many as 4000 times on a single plate with an over-all error of less than 0.0001-inch. Litho plates are coated with light-sensitive material in a centrifuge (upper right) that can accommodate 5 foot square plates. Etching is carried out in several steps on an automatic rotary machine (large photo) at a production rate of 38,000 circuit boards per day.

Photo-Etching Competitively

PRODUCTION of printed wiring and circuit boards by photo-etching techniques demands absolute control throughout the entire process if consistent, accurate results are to be achieved. For example, the manufacture of a large quantity of subminiature printed circuits can be a harassing and expensive proposition if the rejection rate is high because of uncontrolled reproduction methods, chemical solutions, or timing sequences.

Aware of this problem, Printed Circuits Ltd., Boreham Wood, Hertfordshire, England, recently reviewed all aspects of its photo-etching process with a view toward developing equipment and techniques that would ensure high quality products, in both large and small quantities, at least possible cost. Success of their endeavor is evidenced by the fact that the company can produce highly accurate printed boards and components for lower prices than those of similar Japanese products. As an example, printed circuit boards 10 square inches in size can be produced in large quantities for about seven cents each.

The process that has been developed by Printed Circuits Ltd. starts with the preparation of a master drawing of the part to be produced. The drawing, preferably several times enlarged, is made on a dimensionally stable drafting card. After the part has been drawn, hole centers are marked on the card outside the part area. These marks are used later in preparing piercing and blanking tools for finished circuit boards.

In the first photographic step, a negative of the drawing is made to final size in a copying camera. A contact print of this negative is then made on a block of tool steel which has been coated with light-sensitive material. The block is then etched and holes are drilled in the proper locations. From the template thus obtained, a piercing and blanking tool is made.

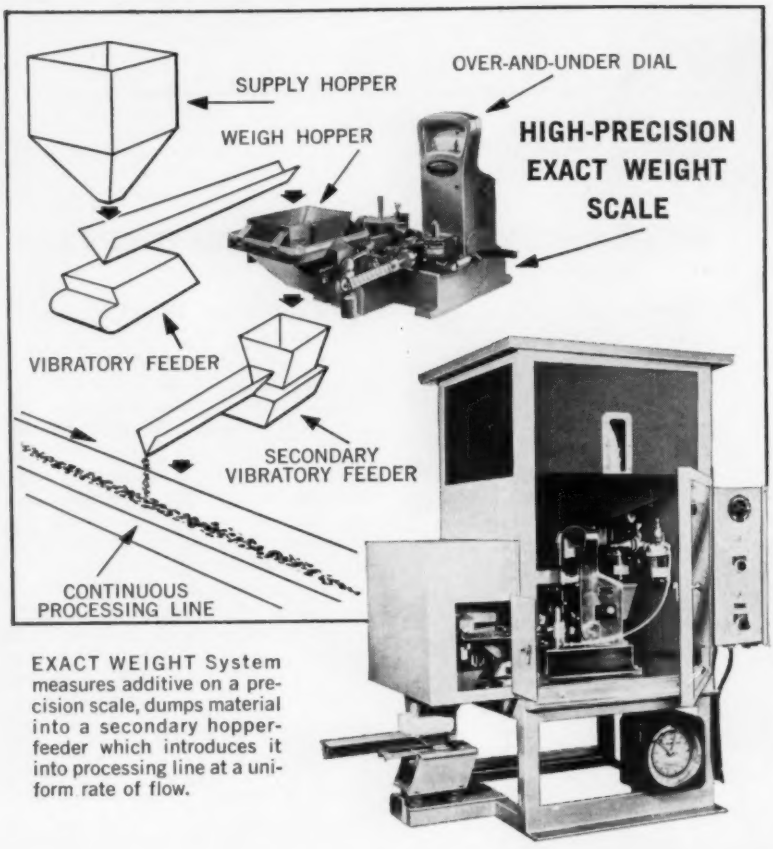
Next, the hole centers are removed from the negative and it is placed in a special "step and repeat" camera. Here, the negative can be accurately reproduced as many times as it will fit on a negative plate size of 18 by 24 inches. The camera is fully automatic and can reproduce, for example, a 2 by 5-inch shape 40 times in 8 minutes.

The next stage involves transferring the multiple copy image from the negative to a litho printing plate. This operation is performed in a dust-free area. To prepare a litho plate, it is coated with a light-sensitive material in a special centrifuge. Then, the image is transferred to the plate by the contact printing method. Development of the plate is accomplished by coating it with a special ink and washing it with water. The ink remains on the circuit pattern.

An offset printing process is used to transfer the circuit pattern from the litho plate to laminated boards that will be etched to form circuit boards. Each board is impressed two or three times to provide an image with good density.

The boards are next fed by conveyor belt through a chamber where they are coated with bitumen dust and baked by means of infrared heaters. This process ensures that the circuit pattern on each board will remain unchanged during agitation in an etching bath.

The etching process is accomplished in an automatic machine resembling a carrousel. Around the base of the unit



EXACT WEIGHT System measures additive on a precision scale, dumps material into a secondary hopper-feeder which introduces it into processing line at a uniform rate of flow.

EXACT WEIGHT® CONTINUOUS WEIGHER inserts additives in precise amounts

This Exact Weight Continuous Weigher inserts loose, free-flowing granular solids into processing lines in exacting quantities. Accurately-timed feeding of material over a given period of time assures controlled integration into the processing stream.

Exact Weight machines of this type are currently being used in the processing operations of foods, chemicals and pharmaceuticals. Machines are fully enclosed for protection against contamination. Models are available in a range of capacities from one gram to 300 pounds.

Exact Weight equipment is backed by more than 45 years of experience in building job-engineered scales for all types of applications. We offer experienced counsel and factual data on the best method for weighing your product. For complete information on the Exact Weight Continuous Weigher, request Bulletin 3311.

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BETTER QUALITY CONTROL . . . BETTER COST CONTROL

are segmented tanks in which various chemical and mechanical processes are performed. A central column includes a hydraulic ram and a series of radial arms whose functions are controlled by an arrangement at the top of the column.

In operation of the etching system, printed laminated boards are suspended on jigs carried by the radial arms. As the arms conveying the boards move around the center column, preselected arms are raised and lowered in accordance with a preset program so that each board is placed in the correct tank for the proper time. In their lowered positions, the arms are oscillated vertically.

In a normal machine sequence, each board is first lowered into a cleaning tank. It is then raised, carried around, and lowered into an etching tank. The etchant, an aqueous solution of ferric chloride, is sprayed as a mist onto the board.

At the conclusion of the etching period, each board is placed in a cold rinse tank where it is washed by high pressure jets of water. The next tank contains a stripping solution that removes the "resist" from the boards. Subsequent tanks provide chemical fixing, a second cold rinse, a hot rinse, and a hot air drying treatment. Following these operations the boards return to a load-unload station where two operators remove the finished boards from the jigs and load the machine with boards to be processed.

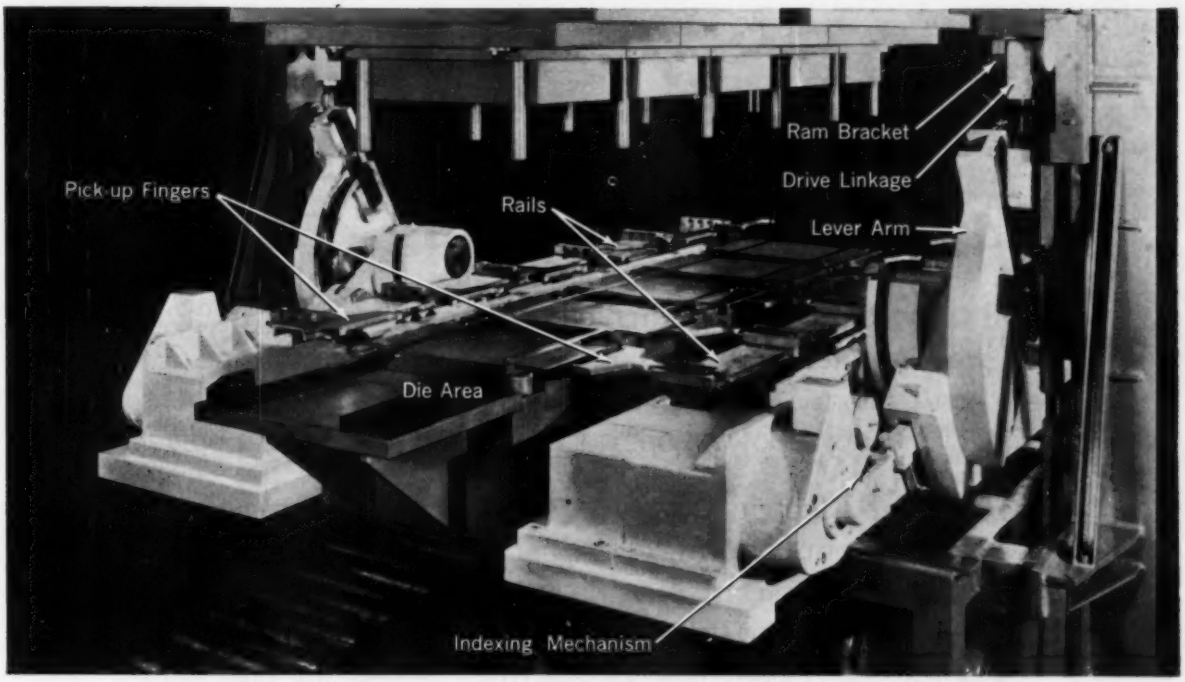
Capacity of the automatic etching machine is 38,000 printed wiring boards per day, of the size used in the average portable transistor radio. Control features include the ability to override any of the processes and to operate the system manually if desired. Processing times, solution densities, and solution contents are controlled automatically. At a prescribed etchant contamination level, valves are automatically opened to draw off the fluid and refill the etchant reservoir with a fresh solution. The contaminated etchant is neutralized and discarded.

The boards taken from the etching machine are next moved to a special spray room where the required finish is applied. After spraying, the boards are carried by an overhead conveyor through an infrared radiant heating oven that hardens the finish.

The boards are then stripped to separate the individual parts on each panel. After this operation, locating holes are drilled in each part to prepare it for piercing of the component holes and blanking. To precondition the boards so that chipping and fracturing will not occur, they are preheated in an infrared oven before stripping and punching. This treatment also facilitates the piercing of small diameter holes. Punching is extremely accurate, since the tool and the printed board are derived from the same negative.

After punching, the boards are routed to an inspection area. Parts that meet quality and performance requirements are then packed and shipped.

Circle 676 on Reply Card



Automate your presses... for BIGGER profits!

Increase your production, improve the quality of your products and get your manufacturing costs down—with your present equipment.

This happy position is being enjoyed now by users of Sheffield PRESS-PACERS—demountable transfer devices which automate any straight side press or line of presses. Parts can be transferred from die to die in one press, or between presses in lines up to more than 125 feet long.

One press can be made to do the work of as many as five or six presses, reducing equipment and space requirements. The number of transfer operations is limited only by the capacity of the press or line of presses involved. Automatic handling from press to press prevents scrap generated by manual handling.

PRESS-PACERS are completely flexible. They have been tooled to handle interchangeably as many as seven parts. Model or engineering changes do not obsolete a PRESS-PACER—they only increase its value.

Blanks, pre-drawn parts, sheet and coil stock may be used, as desired. Feed fingers are interchangeable—feed distance is adjustable.

Sheffield provides complete single-source responsibility in PRESS-PACER production including (1) design and build tooling, (2) building of standard PRESS-PACER, (3) provision for minimum scrap and scrap removal, and (4) installation in your plant, warranted to perform to specifications and your satisfaction.

You can see eight different PRESS-PACER installations right in your plant by means of a sound movie in color—and discuss your opportunity for savings with a factory engineer . . . write, wire or phone Contract Manufacturing Division.

The **SHEFFIELD** *Corporation* *Dayton 1, Ohio*

A subsidiary of The Bendix Corporation

Gages, Measuring Instruments, Automatic Gaging & Assembly Systems • Machine Tools • Contract Mfg.

General Electric Makes Eddy-current-coupling Drives

And they're dependable drives. The complete line includes water-cooled and air-cooled eddy-current couplings. We call them KINATROL* drives. Ratings are from 1 to 150 horsepower, operating from standard a-c power.

A General Electric KINATROL drive is not just another eddy-current coupling. For instance, in the water-cooled coupling, water control is packaged. You'll see much less external piping. Furthermore, the coupling is protected from flooding—and the air gaps are dry, preventing corrosion.

KINATROL couplings are compact, field proven and dependable. General Electric has had a good deal of experience in the engineering, manufacturing, and application of packaged adjustable-speed drives. And we know how important service is to a customer.

KINATROL —a good product, with the kind of service you can depend on. Please call your nearest General Electric Sales Office for further details.

*Trademark of General Electric Company

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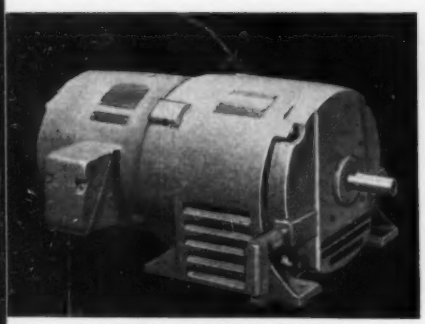
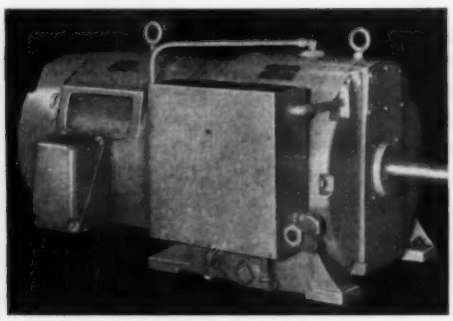
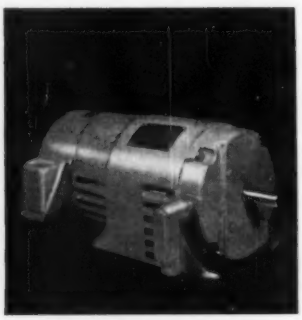


AIR COOLED, 7-1/2 to 100 HP



WATER COOLED, 25 to 150 HP



AIR COOLED, 1 to 5 HP

DIRECT CURRENT MOTOR AND GENERATOR DEPARTMENT

GENERAL ELECTRIC

ERIE, PENNSYLVANIA

Circle 678 on Reply Card

Double Challenge

Many people in the United States share the delusion that we in this country have a monopoly on technical know-how and that other countries compete in world markets solely with obsolete equipment and underpaid labor.

Don't believe it!

What is happening is this:

An industrial and economic revolution is taking place that will have greater impact on all of us than the one that started in England late in the eighteenth century and swept over to the U. S. a few years later.

Already, France, Germany, Italy, Belgium, Luxembourg, and Holland are linked in the highly-successful and prosperous European Economic Community.

By 1963, in all likelihood, the EEC will be joined by Great Britain and the other six members of the European Free Trade Association.

The 13 countries then will have a common market with a combined population that will increase from 258 million people today to 278 million by 1970. The U. S. now has 182 million people.

On our travels through Europe, we found engineers in those countries feverishly at work applying the latest automation and mass production techniques that will be needed to compete in an unrestricted market.

Significantly, they not only are applying American techniques but are generating many innovations of their own.

Even more significantly, the Kennedy Administration wants the U. S. to become part of a huge western world common market for the purpose of knitting the West more closely together. In this entire market goods would move as freely as between the 50 states.

Then, more than ever, American manufacturing engineers will be called upon to develop even more sophisticated automation systems to meet the double challenge of modern technology and lower wage rates abroad.

The challenge must be met if our industry is to survive!

Irwin H. Such

VICE PRESIDENT-EDITORIAL

AUTOMATION

a project

Case study of the development of a complex automated machine traces the project from the establishing of objectives through the stages of estimating, proposal engineering, justification, design, build, debugging, installation, and evaluation.

SHALL WE AUTOMATE?

EDWARD H. GRUMICH has held positions of vice president in charge of manufacturing, plant superintendent, production manager, industrial engineer, and product designer in the 27 years since his graduation from college. He holds a B.S. degree in Mechanical Engineering, which was received from the University of Missouri. He also attended Purdue University and the University of Chicago. His experience has included manufacture of such products as wheels, automobile accessories, metal windows, escalators, ball bearings, job shop tools and fixtures, and aircraft engines and carburetors. Since joining the Parker Pen Co. 14 years ago Mr. Grumich has been chief industrial engineer, director of research, and for the last six years, chief engineer.

PREPARING THE PROPOSAL

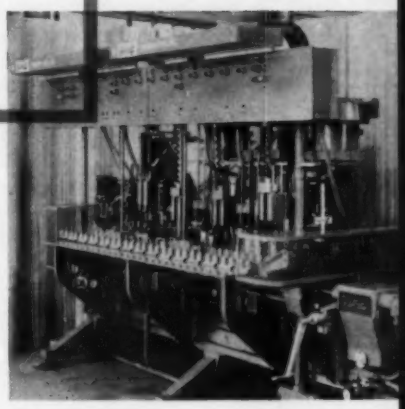
CHESTER C. HOLLOWAY received his B.A. in Business Administration from the University of Florida and his M.B.A. from Harvard University. He served as an Ordnance Officer, Lt. Colonel United States Army. Prior to his present position of president, Gilman Engineering & Mfg. Co., Mr. Holloway was vice president in charge of product planning for the parent company, the Parker Pen Co.

ASSEMBLING PEN CAPS

LYELL C. TULLIS received a B.S. degree in Engineering from the University of Wisconsin. In 1938 he joined Baker Mfg. Co. of Evansville, Wis., as a member of their engineering department concerned with engineering of domestic water systems for manufacture. In 1951 he accepted the position of assistant chief engineer at Gilman Engineering & Mfg. Co. Now as chief engineer of that firm Mr. Tullis is involved with planning and developing designs for automatic assembly machines and special production equipment such as secondary machining equipment applied to parts on a high volume basis.

These articles are based on papers presented at the "Fifth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and the Manufacturing Engineering Council, April 1961.

analysis



SHALL WE AUTOMATE ?

By E. H. GRUMICH, Chief Engineer, Parker Pen Co., Janesville, Wis.

DOES YOUR top management understand automation? I have talked to many engineers about this problem of understanding. So many have told me that if their top management understood automation, their problems would be much more simple.

The typical reaction was that many of their top management personnel would visit another plant, wholly unrelated to their products. There they would see a network of conveyors, automatic processing equipment, and automatic material handling. They would then return and immediately want to automate their plant without regard to their product, product mix, product volume, and quality control. As we are all aware, basic attitudes are very important. Top management must first understand that automation is not a cure-all for their problems.

In any automatic equipment, the final product, and the efficiency of the equipment, is only as good as the parts which are fed into the machine. If the product is such that its function does not require close tolerances but the parts would require close tolerances to be assembled in an automatic machine, the automation program may be easily defeated because it will have absorbed all of the cost reduction in refining individual parts to be assembled automatically.

Another very important facet of automation is how far to automate. We have had some very costly experiences in this area. When laying out an automation program do not defeat it by designing one machine to do everything and then find that the machine will not work.

Transferring work from one machine to another is sometimes more simple than trying to accomplish the next group of operations on the same machine. In many cases, breaking down the equipment into groups of operations with automatic transfer will give more flexibility, easier maintenance, and in some instances the equipment will be less costly.

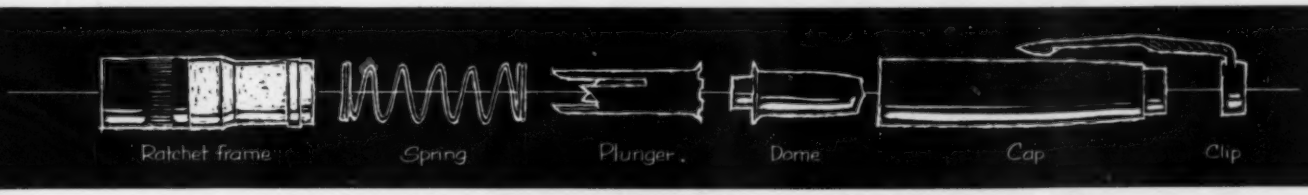


Fig. 1—Latest design of component parts that make up the cap assembly of the Parker Pen Company's T-Ball Jotter ball point pen.

There being no formula for the guaranteed success of automation, there is, therefore, a certain amount of risk connected with this type of venture. The risk depends on the size of the project and the results that might be harvested from the success.

In developing new products, the development engineer must be in a position to make compromises on product design, both functionally and aesthetically. A little later in this discussion it will be pointed out why compromising is necessary, as this is a very important step in automating any product. One part of a series of parts to be automated, that is not designed for automation, can defeat a program. Whenever it is possible, this troublesome area should be ironed out by checking that particular part and operation on an improvised basis.

Our experience has been that whenever going into an automation program the burden rate will increase because of a reduction in direct labor and the addition of burden factors, such as the amortization of new machines and tooling. As the automation program increases so will the engineering staff, tool room, and maintenance.

Whenever required to explain why the burden increased due to automation, point out the factors involved and be sure to explain that with automation a higher burden rate is applied to a lower direct labor cost.

Another must in an automation program is to obtain a fairly accurate sales forecast in both volume and product mix. In order to justify automation there must first be sufficient volume to justify your program. It is also essential to work constantly with the development engineers in order to be flexible to make conversions to the next product if the one selected to automate becomes obsolete. This is where most automation programs collapse and are expensive. A company will invest a great deal of money automating one product without giving any thought to flexibility to utilize this equipment on a future product.

▶ Automation Applications

In companies that are cost-minded, and certainly most companies are, there are usually two types of automation programs going at the same time: 1. Planning of automation for products due to be released in the future. 2. Automating of existing products. The case study to be discussed here is the automating of an existing product.

Our biggest volume product has been, and still is, our T-Ball Jotter ball point pen. This model was to be redesigned and repriced for a new price market, and since the forecast indicated a higher production volume this gave us a perfect product to study for automation. This is the subject which will be discussed—our present T-Ball Jotter ball point pen which now retails for $1.98.

Our present, improved, design of the Jotter cap assembly, *Fig.* 1, consists of the cap, clip, ratchet frame, plunger, spring, and dome. The ratchet frame has two cams molded on the inside wall of the frame. The plunger also has a set of cams which are formed, and adjacent to these cams is a set of longitudinal slots. The slots in the plunger straddle the cams in the ratchet frame and move in one plane.

The plunger is opposed by a spring. This spring is assembled between the two parts. The dome then fits into the plunger and that assembly is press-fitted into the cap-clip assembly. The cap is then stamped using the clip as an index. The cams in the plunger, with the aid of the cams in the ratchet frame, work on a friction principle thus repelling and propelling the cartridge with the ratchet and at the same time rotating the cartridge to give the ball seat uniform wear when writing. This is the

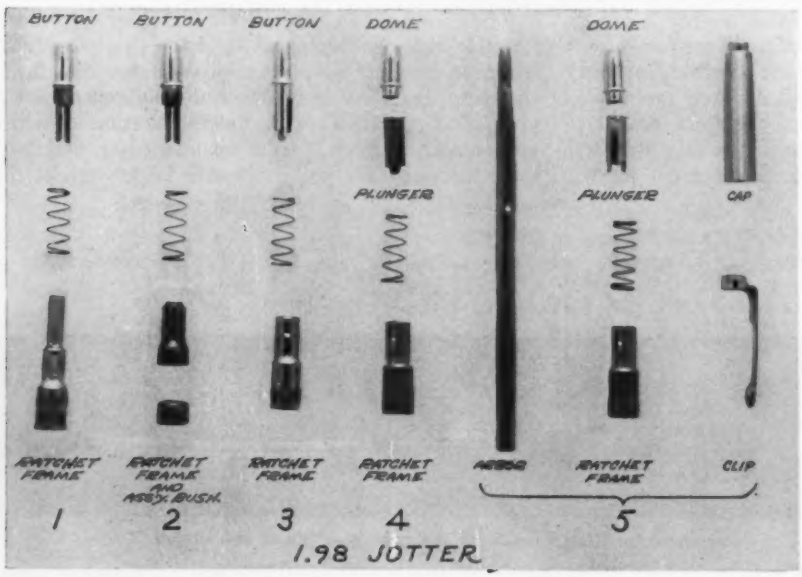


Fig. 2 — Successive design stages show evolutionary changes in product design to produce an improved product at lower manufacturing cost.

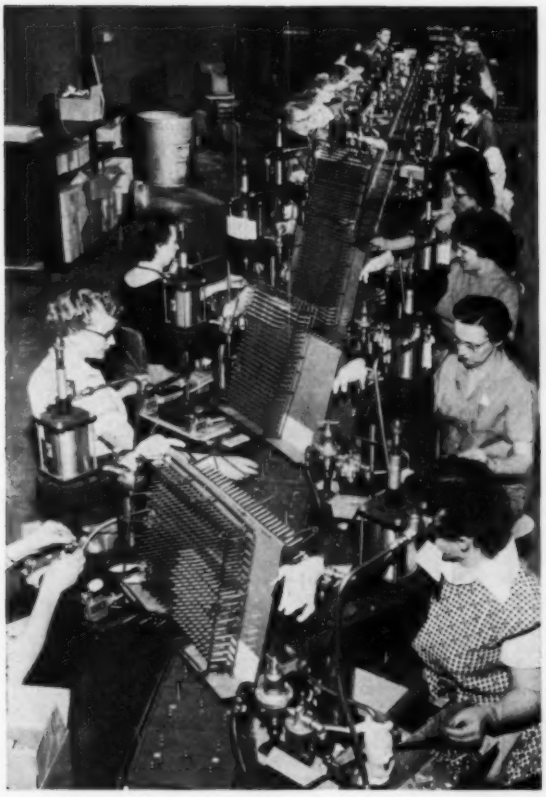
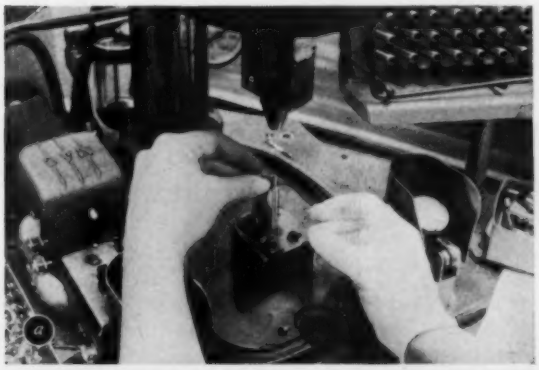


Fig. 3—Arrangement of workstations on right and left sides of conveyor shows layout of original manual technique of assembly *(a)* First workstations assemble clip to cap. *(b)* Manual stamping fixture applies identification. *(c)* Internal parts are assembled and press fitted to cap. *(d)* Finished cap assemblies are inspected.



only ball point pen on the market with this feature. This product sells in the millions a year and has good anticipated length of time to remain in our product mix.

We have a continuous program of cost reduction and we had been constantly working on this same cap assembly. This cap has gone through a process of evolution to reduce the cost through design and materials and ultimately arrive at a product that could be automated. The steps of this evolution as identified by numbers in *Fig.* 2 are as follows.

1. This was the original design that was manufactured for a short period of time. In this discussion it is used as a basis of cost, and all reductions are referred to this design as 100 per cent. Note that even though there are only three parts, two of them are very expensive to manufacture.

2. The cost was reduced five per cent. This was accomplished by a change in the design of the ratchet frame. This only enabled improvement of assembly technique.

3. The cost was reduced 32 per cent from the original design. This was a change in the design of the button and ratchet frame, and the assembly operation was transferred to a belt conveyor for assembly as shown in *Fig.* 3.

4. The cost was reduced 49 per cent from the original design. This was a change in the design of the dome and plunger, the plunger being made from flat stock on a progressive die, instead of a

drawn and fabricated part. The dome is now made on an eyelet machine.

5. During the study of indexing we designed an arbor that would automatically self-align the ratchet frame cams in relationship to the plunger guides. There was no reduction in standard cost but a definite reduction was made in rejects. This self-alignment feature immediately gave us a clue that automation of this assembly was possible and feasible.

In the latest revision, *Fig.* 1, the cost was reduced 53 per cent from the original design. The cost reduction was due to the redesign of the ratchet frame —from a drawn part with secondary operations to a molded part with a screw machined insert.

The parts listed in *Fig.* 1, are the current parts that are now being run on a Gilman Transferline automatic assembly machine. By changing the process from a conveyor line assembly to this machine the cost was reduced 60 per cent from the original design.

The original method of assembly on the conveyor line was a manual technique. The process was performed by operators seated on both sides of a conveyor, *Fig.* 3. They performed the following operations: 1. The first six assembled the clip to the cap. 2. The next four stamped identification marks positioned with respect to the clip. 3. The next ten assembled the internal parts and press-fitted the clipped cap to the assembly. 4. The next two operators (indirect labor) inspected the finished assembly. 5. The final operator disassembled rejects and sorted good parts from the rejected assemblies.

How Far to Automate?

We felt that by going further than the cap assembly we would run into serious problems of feeding highly polished plastic parts and encounter problems of color mix, point sizes, and ink colors in cartridges. Having come to the conclusion that

Fig. 4—Worksheets illustrate typical information used as basis for the decision to automate. Financial Review sheet summarizes cost and savings figures; Schedules I through IV are used to develop the information.

PARKER PEN COMPANY

Financial Review - Gilman Transferline Assembly Machine for #1.98 Jotter

Machine Cost - Gilman's Quotation 3 February 1960

Basic Machine - 10 Years' Depreciation	$46,332.00
Tooling for #1.98 Jotter Cap Assembly (18 months)	36,468.00
TOTAL	$82,800.00
Additional Tooling For Assumed Cap Modification	$15,000.00

Estimated Annual Savings - Direct Labor and Fringe Benefits Only

First Year - Schedule I	$76,700.00
Second Year	$81,600.00
Third Year	$79,700.00

Financial Review sheet is the schedule of figures showing cost and saving figures. Cost of the basic machine and tooling are known from the vendor's proposal. The "Additional Tooling" entry is an estimate of anticipated conversion cost when the product becomes obsolete or requires redesign. The rest of the information is developed from Schedules I through IV.

PARKER PEN COMPANY

Schedule I

Present Standard Direct Labor	100%
Estimated Standard Direct Labor - Gilman Transferline (Schedule II)	36%
Estimated Gross Savings Direct Labor - Gilman over present method	64%
First Year's Forecast - Assemblies	
Estimated Direct Labor Savings - First Year	$61,699.00
Estimated Fringe Benefit Savings	$14,976.00
Total Estimated Savings - First Year	$76,675.00

Schedule I presents a determination of type of savings that can be realized. Direct labor cost of the present method is already known. Estimated standard direct labor cost on the proposed machine is obtained from Schedule II. Using this data the estimated gross savings direct labor for the proposed machine over present method is calculated. First year's forecast is obtained from the Financial Division. First year's direct labor savings can then be estimated. Savings in fringe benefits can then be added to the direct labor savings to come up with a total estimated first year's savings.

PARKER PEN COMPANY

Schedule II

1. Gross Production Per Hour Transferline	2880 Pieces
80% Efficiency Per Hour	2330 Pieces
Estimated Standard Production Per Hour	2013 Pieces
(Standard production reflects actual machine utilization of approximately seven hours on eight-hour shift)	
2. Estimated D/L Per Hour - Machine Assembly	$8.71
3. Estimated Standard D/L Cost Per 100 Assemblies	36¢
(36¢ is on Transferline over present method. Present method used as 100¢)	

Schedule II develops estimated direct labor costs. Gross production and production of the proposed machine at 80 per cent efficiency are determined from the proposal. Estimated standard production is based on our estimate that the machine will run 7 hours per shift. At proposal and pre-proposal meetings such things were discussed as feeding parts, dexterity of operators, quality control, quantities required, inspection, etc. Based on these discussions the proposed number of operators was determined and the estimated direct labor per hour calculated. From the estimated standard production per hour and the estimated direct labor per hour the estimated standard direct labor cost per piece was calculated. On this proposal it was 36 per cent of that for the existing method.

we did not want to risk our quality, we decided to stop with the cap assembly.

Then the question confronted us in making a decision on whether to: 1. Design and build and tool our own automatic equipment. 2. Design and have an outside company build and tool our equipment. 3. Have an outside company, specializing in automation, design and build and tool our equipment.

After taking into consideration our Engineering and Tool Room load, and the completion date, we decided that in order to do this job in the fastest possible time we would call in several companies for proposals. In choosing the companies, we took into consideration the following: 1. Reliability. 2. Engineering talent. 3. Experience in designing and building automatic equipment. 4. Policy of the company doing the work. 5. Delivery. 6. Ability to work with our engineers. The last item, although listed last, is very important. Even though you give an outside company the responsibility of designing a machine to produce a series of operations, they must rely on your engineers and production management to help them. Without this help the automation program is jeopardized. No outside company knows your standard of quality and your problem better than you know it yourself.

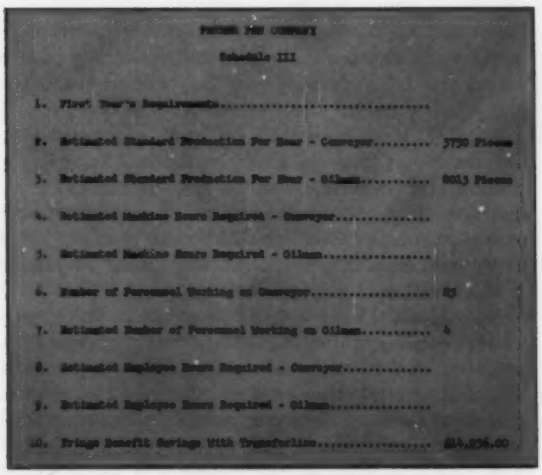
After screening several companies and placing one of our own divisions in direct competition, we proceeded with the following: 1. Defined the limits of how far we wanted to automate the cap assembly. 2. Defined the quality and the A.Q.L. of each part going into the assembly. 3. Defined what A.Q.L. we would like to have in the final product. 4. Invited their team of engineers to study our single station operations on the conveyor. 5. Briefed them on quantity required per 8-hour day. 6. Discussed the necessity for flexibility. 7. Discussed the delivery date. 8. Discussed our preference of electrical equipment. 9. Had their engineers and designers discuss level of quality acceptance with our Inspection Department. 10. Discussed the dexterity of our operators. 11. Discussed manual feeding versus automatic feeding. 12. Discussed maintenance and performance of electrical equipment. 13. Pointed out the troublesome areas of our present single station operations.

After several months of communications with these companies and their engineers, general proposals were submitted. Now you must realize that at this stage proposals are general.

▶ Financial Review

It is advisable to acquaint the Financial Division with each project as early in the program as possible. If you do not, too many times you come up to the finish line only to find that you are riding a dead horse. They should be able to supply standard costs and product mix data, and make economic studies for the program.

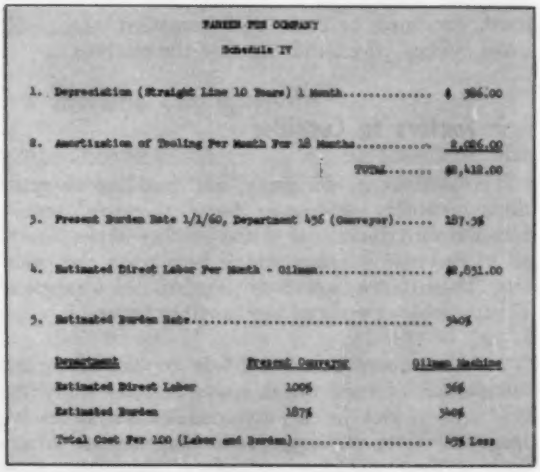
It must be appreciated that we have a great deal of respect for our competitors, and having this respect we omit some actual figures, showing percentages for this discussion. The Financial Review, *Fig.* 4, is the recap of the information on which we based the decision whether to automate or not. As shown by the schedules for the cap assembly, the total cost of the machine and tooling amounted to $82,820. Our estimated first year's savings amounted to $76,700; second year's to $81,600; and third year's to $79,700.



Schedule III

1. First Year's Requirements	
2. Estimated Standard Production Per Hour - Conveyor	3750 Pieces
3. Estimated Standard Production Per Hour - Oilmm	8033 Pieces
4. Estimated Machine Hours Required - Conveyor	
5. Estimated Machine Hours Required - Oilmm	
6. Number of Personnel Working on Conveyor	83
7. Estimated Number of Personnel Working on Oilmm	4
8. Estimated Employee Hours Required - Conveyor	
9. Estimated Employee Hours Required - Oilmm	
10. Fringe Benefit Savings With Transferline	$14,976.00

Schedule III presents a calculation of fringe benefit savings. Whenever the number of operators is reduced so is the cost of fringe benefits. First-year requirements for assemblies is estimated from the forecast. Estimated standard production per hour for the proposed machine is drawn from Schedule II. The machine hours required and the number of employee hours required are then estimated. Taking into consideration fringe benefits per employee hour the fringe benefit savings are calculated.



Schedule IV

1. Depreciation (Straight Line 10 Years) 1 Month	$ 386.00
2. Amortization of Tooling Per Month For 18 Months	2,086.00
	$2,472.00
3. Present Burden Rate 1/1/60, Department 456 (Conveyor)	187.5%
4. Estimated Direct Labor Per Month - Oilmm	$2,051.00
5. Estimated Burden Rate	340%

Department	Present Conveyor	Oilmm Machine
Estimated Direct Labor	100%	36%
Estimated Burden	187%	340%
Total Cost Per 100 (Labor and Burden)		45% Less

Schedule IV sets down data on burden rate. Going into an automated setup changes burden rate, and to arrive at a realistic saving figure the change in burden rate must be taken into consideration. The cost of the machine is obtained from the proposal, and for depreciation purposes our Accounting Dept. used 10-year straight line on this machine. The cost of tooling shown by the proposal was to be amortized over 18 months. Present burden is known for the present method. With an estimate of direct labor based on Schedule II, a new burden rate can be figured. In this example our burden rate almost doubled. However, our total cost, labor and overhead, drops 45 per cent (calculated using actual cost and not percentage cost).

a project analysis

PREPARING THE PROPOSAL

By C. C. HOLLOWAY, President, Gilman Engineering & Mfg. Co., Janesville, Wis.

THE VENDOR'S proposal and estimating procedure is really a partnership with the purchaser in attempting to answer the question "Should You Automate Assembly?" Frequently, neither the purchaser nor the vendor alone has at hand, all the information or tools he needs to determine whether a particular assembly should be accomplished automatically. A joint effort is required to make a complete analysis and to develop the most effective solution.

A vendor lives by his reputation for successful installations. He therefore has a broader interest in his customers' problems of mechanizing assembly than might be expected. The cost of proposal preparation is an expensive item. As mentioned in the Fourth Conference on Manufacturing Automation last year, the customer must ultimately pay for this "free engineering." Therefore, it is important that the customer make a preliminary analysis and develop serious intent prior to requesting proposals from the vendor. It is equally important that a frank disclosure be made of information which will avoid wasted effort and expedite the analysis.

Factors to Consider

The estimating, designing, and building of automatic assembly equipment for a *successful* installation is directly related to the validity of the analysis of the many factors which bear upon the problem. These factors are both tangible and intangible. First, a look at some of the tangible factors:

1. **Volume and Labor Cost**—In contemplating the automation of mechanical assemblies, naturally the first area to look for is for assemblies which involve large labor cost and large production volume. Where both of these elements are present, the chances are good that the expense of capital equipment to perform automatic assembly operations can be justified.

It is fairly simple to determine, by rule of thumb methods, whether an automation study is justified. *First,* the average annual cost of an assembly operator should be ascertained. We have found that this varies from a low of $4000 per year, to a high of $9000 per year. A good average would be $5000 per year. The *second* step is to determine the number of operators used in hand assembly. Multiplying these two will give the annual potential labor savings. If 10 operators are saved at an average cost of $5000 per operator, it is apparent that the savings would provide for significant equipment and that a study should be initiated.

Where large volume production requirements exist, but assembly labor cost is moderate, a more difficult analysis is required. In this case, considerations other than cost savings alone may justify automatic assembly equipment. Some of these reasons are discussed later.

A still more difficult evaluation results when automatic assembly machinery is being considered for an assembly which involves considerable labor, but low volume production requirements. Products falling in this category by definition are complex, hard to handle, or involve special problems which would lead to complicated and expensive equipment to perform the assembly operations automatically. This in turn demands a higher probability that the design will be stabilized to avoid obsolescence of the equipment. In considering the automatic assembly of products which fall in this category, it is important to analyze the design and present processing methods to gain a full understanding of just where the labor costs are in the present assembly, and then consider the various alternatives for removing it. It is important to avoid attempts to do too much on one assembly machine. It may be possible for subassemblies to be automatically assembled with great effectiveness, whereas attempts to automatically assemble the entire product on a single machine may approach the point of diminishing return and prove uneconomical.

2. **Product Design**—In determining specifically what assembly functions should be performed by machine, the vendor, of course, must understand all elements of the product design. He should, therefore, be taken into confidence by the purchaser in an analysis which will reveal related products which might also be accommodated on the assembly machine under consideration. Also, it is important that he know what elements of the product design are subject to change so that equipment may be designed with flexibility which anticipates such changes.

Where variations of a basic design exist for dif-

ferent models, it is necessary to ascertain the "design pattern." This analysis is essentially a frequency distribution chart to ascertain which designs appear most frequently. Then the design variations are considered in relation to each other and compared against the additional cost which might result if the machine were to be designed with the flexibilities required to handle these model differences. Once the model design pattern, or the parameters of design have been isolated, it is surprising the flexibility which can be built into automatic assembly equipment. We have, for instance, delivered equipment which is capable of assembling, with quick changeover procedures, 27,500 different models of an electrical device.

3. **Space**—Automatic assembly equipment saves space and this can be an important cost consideration.

4. **Quality**—Automatic assembly machines are, to a certain extent, also automatic inspection machines. As the builder of automatic equipment is primarily interested in production yield, he does not normally stress the inspection aspects of the equipment. However, an assembly machine is a ruthless inspector, and with proper forethought, inspection standards can be built into automatic equipment which almost invariably yield an improvement in the quality and reliability level of the completed assemblies.

5. **Technical Requirements**—Last, but not least of course, among the tangible considerations in determining whether you should automate, are the technical characteristics of the problem which determine the feasibility of automation itself. While most technical problems can be overcome in one manner or another, in some instances it may not be economically justifiable to entertain the expense required. In other instances, the purchaser must take the vendor into confidence and co-operate by making product changes which will render the product more readily adaptable to automatic assembly. A very minor change of product design may have a profound effect upon technical feasibility.

In addition to the foregoing tangible considerations, a number of intangible considerations have equal validity in determining whether you should automate.

1. **Stability of Design**—As most automatic assembly equipment involves considerable engineering and tooling expense, even though the basic elements of the machine may be standardized, it is apparent that the design must be relatively stable to justify automation. Although we have heard of many complaints of loss resulting from automation investments becoming useless due to product changes, it seems apparent that more automation opportunities are lost because of the inability of companies to determine the stability of their designs. At least in our own experience, there are many instances where machine orders were lost because no one in the purchaser's company had the foresight, authority, or courage to make a commitment of product life. Yet these same products have continued on and on.

From the vendor's point of view, it sometimes appears that the greatest problem in automation as applied to automatic assembly, is not a technical problem, but a business problem for management to have the courage of standardizing design for an adequate period of time to reap the economic harvest from automation, and to have the leadership to develop the atmosphere within the organization to accept and exploit the opportunities in this age of automation!

2. **Machinery Oriented Atmosphere**—For want of a better phrase, we say that the "atmosphere" of a company is one of the more important intangibles in determining when to automate. Sometimes the top management of a company is anxious and straining at the bit to automate, while at the plant level, either the engineers or production personnel may be fearful of the challenges which this modern equipment presents. In other cases, the opposite holds true. And we all know of the natural fear which the laboring man has that machinery will displace his job. The sociological and the psychological factors involved in automation are not to be underestimated.

Some companies are simply not prepared to successfully undertake an automation program from a cold start. Frequently, the vendor can be of great assistance in this regard, however. For instance, in our case, we show films of successful equipment installations to management, engineering personnel, maintenance and plant personnel. We arrange for visits of interested personnel to plants where we have installations so that they can see our machines in operation and gain an appreciation of, and confidence in, their reliability. We offer a free training course to the purchaser's personnel, during the final assembly stages of our machines so that when the machine is delivered to his plant, the machine does not arrive as a threat, but rather as a friend.

▶ Machine Cost Estimate

After consideration of all of the foregoing, and close association with the purchaser, a vendor is in a position to make an intelligent estimate. Frequently, this estimate will be tentative, for it has been our experience that many of the factors to be considered involve information which is not initially available to the project engineer who is studying the project. However, armed with an initial estimate, he is in a position to request such information so that he can make an analysis of the cost vs. anticipated benefits.

The foregoing almost invariably generates alternatives of what work the machine should accomplish, and various machine design alternatives to accomplish the work. Examples of factors which generate the alternatives are: Possible process changes; product changes; product mix to be assembled on the machine; and the question of whether two machines should be purchased or one machine dual tooled.

Based upon an analysis of these alternatives, and also the results of the experimental work which

we undertake, we are then in a position to present a formal proposal. The proposal generally identifies the assembly to be accomplished and its component parts by print number, and describes the sequence of operations which will be accomplished on the machine. We enclose our standard machine description sheets and contract clauses and normally quote a firm price and delivery schedule. If there is a *serious* question of technical feasibility covering a particular operation, we prefer an initial contract for experimentation to satisfy both the purchaser and ourselves that the problem can be solved. This is preferable to providing large contingencies in the quotation to cover problems of unknown dimensions.

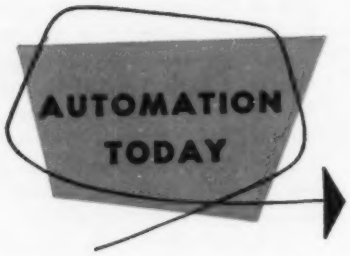
In the presentation of the proposal, we feel that we are an extension of the purchaser's engineering department. At this stage, technical feasibility is not the problem. The technical aspects have been resolved at this stage. The problem is a business problem. Accordingly, we welcome the opportunity to present our proposal to purchasing, controller, and general management personnel. More frequently, however, the purchaser's engineering department carries the ball at this stage, for it is more familiar with the intimate relationships and internal procedures of the company.

Case Study

The one element which was of prime concern in the planning stage of the Parker Pen cap assembly machine, was whether the cap marking could be successfully accomplished on the assembly machine.

By experimentation it was determined that a new control, i.e., control the depth of marking by pressure only, would work satisfactorily for this marking operation. With this solution, it was decided that a marking station could be included on the machine and by so doing, eliminate many other proposals which assumed that the subassembly of the clip to the cap and the marking had to be done prior to the loading of these elements to the machine.

Without going into further detail of the reasoning for the various alternatives, this example indicates that considerable analysis is required to arrive at the best automation solution to each automatic assembly problem. Gilman and Parker engineers worked together in numerous conferences. During the estimating process, not only were various machine alternatives considered—such as single tooling, dual tooling, quadruple tooling, tandem tooling of the machine—but also experimentation was undertaken to ascertain the feasibility of hoppering and automatically loading difficult parts and comparing this cost with manual operation. It is noteworthy that for this particular assembly eight estimates were made, although it is a relatively simple assembly. In more complicated cases, there are design variations of related models which must be taken into consideration; whereas in this case, only one cap design was under consideration.



IN THE DISCUSSION of the equipment to produce a very specific assembly, it is best that at first we describe the basic machine on which this particular assembly will be produced. Many times the assembly machine is a very special machine designed to produce only the given assembly using very few basic components. The results of such conditions usually are a very high machine cost and a very long period of time required to design and build such a piece of equipment.

It can be shown that within a given area there is sufficient repetitive use of elements justifying standardization. The medium size assembly of up to fifteen pieces has had many successful applications of standardized equipment.

A basic machine which seems ideally suited to this cap assembly problem will now be discussed. This particular product requires a fixture in order to complete its assembly. It is also to be noted that in order to produce this assembly it is necessary to incorporate manual operations along with the automatic operations. The reason for this is that the caps which are regarded as an appearance item have a finish requirement which will not permit hoppering. The final operation also required is a manual inspection operation of both marking conditions and a functional check of the button actuation. The accompanying illustrations show the arrangement used to assemble the Jotter pen caps on a standard basic machine.

Machine Layout

The basic machine provides an arrangement of fixtures and a circulating loop plan which is very well suited for the initial manual placement of the cap on the fixture and its circulation to the automatic side of the machine. On that side is accomplished the completion of the automatic loading opera-

a project analysis

ASSEMBLING PEN CAPS

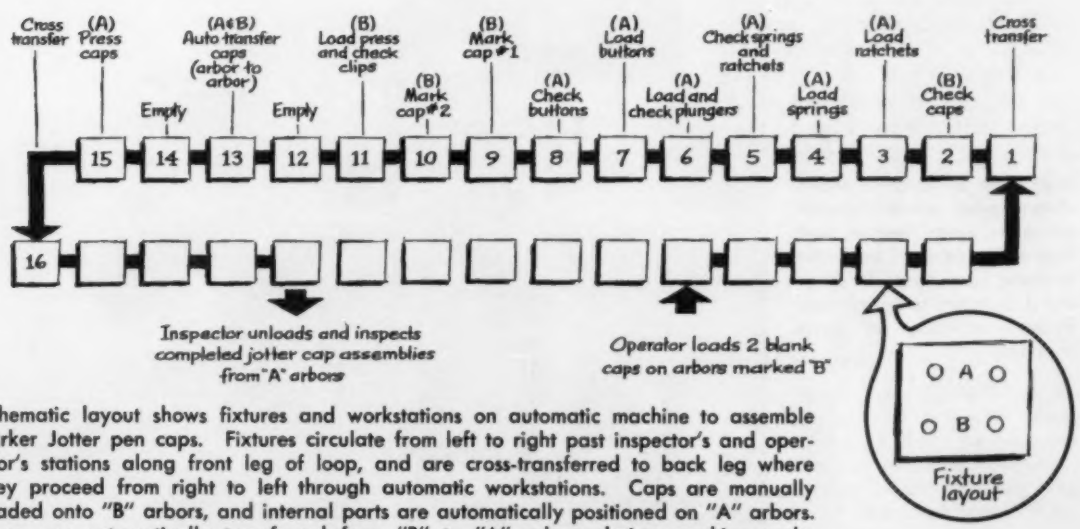
By L. C. TULLIS, Chief Engineer, Gilman Engineering & Mfg. Co., Janesville, Wis.

tions of the parts, including the marking operation of the cap, press fit of the clip to the cap, and the press fit of the cap over the internal assembly. The completed assemblies are then transferred on the fixture system back to the operator's side of the machine for manual unload and inspection and loading onto special trays.

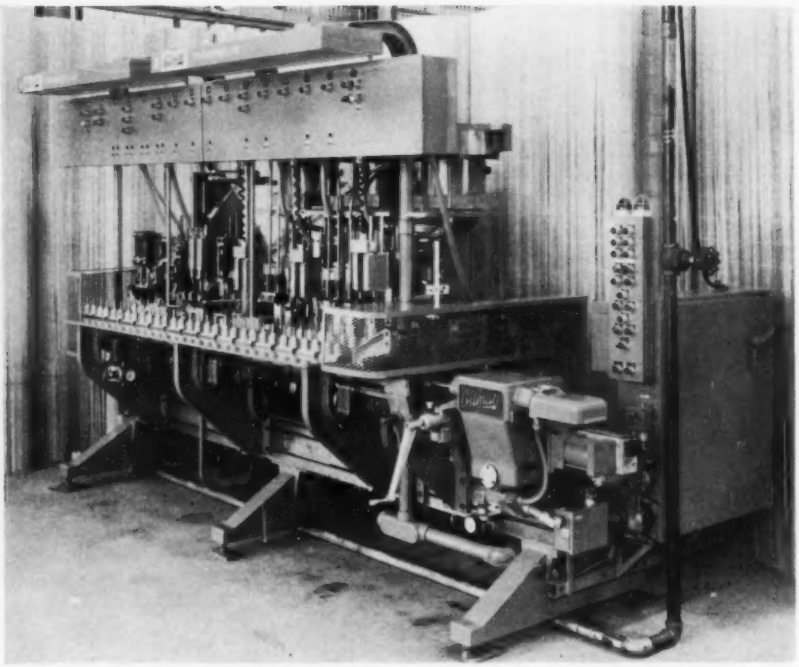
The machine arrangement provides an open layout on the operator's side which enables the observation of proper functioning of workstation mechanisms on the automatic side. The control circuit includes a memory procedure for locking out successive work actions when an incomplete assembly proceeds down the line. A switch is included which can be set to simulate a bad assembly for setup purposes.

Because of the production requirements and relatively small size of this assembly, a double tooled machine worked out very well, both from a cost consideration and a production output standpoint.

Each of the fixtures contains four arbors. The arbors which are identified as the "*B*" arbors are the arbors over which the cap blank is manually placed. These particular arbors must also be mounted in antifriction bearings in order to accomplish the rolling marking operation. They also are provided with a frictional grip which is sufficient to retain the cap on the arbor and also to provide the driving force to rotate the arbor with the cap. An additional friction element is provided on the arbor itself so that after the marking operation is completed a



1 Schematic layout shows fixtures and workstations on automatic machine to assemble Parker Jotter pen caps. Fixtures circulate from left to right past inspector's and operator's stations along front leg of loop, and are cross-transferred to back leg where they proceed from right to left through automatic workstations. Caps are manually loaded onto "B" arbors, and internal parts are automatically positioned on "A" arbors. Caps are automatically transferred from "B" to "A" arbors during machine cycle.



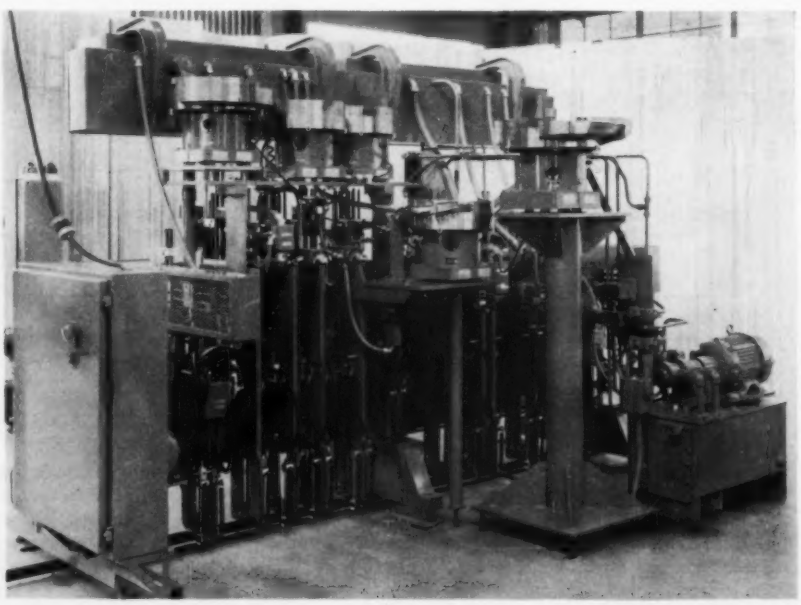
2

Over-all view of front of pen cap assembly machine shows power units at right that move fixtures to successive stations and actuate camshaft which operates workheads. Panel above machine includes lights that indicate results of checks on machine movements and part placement. A memory system locks out work movements when an incorrect assembly proceeds down the line.

specific arbor position will be maintained relative to this marking. Then when the clip is loaded and pressed over the cap, it will have its required angular orientation relative to the marking.

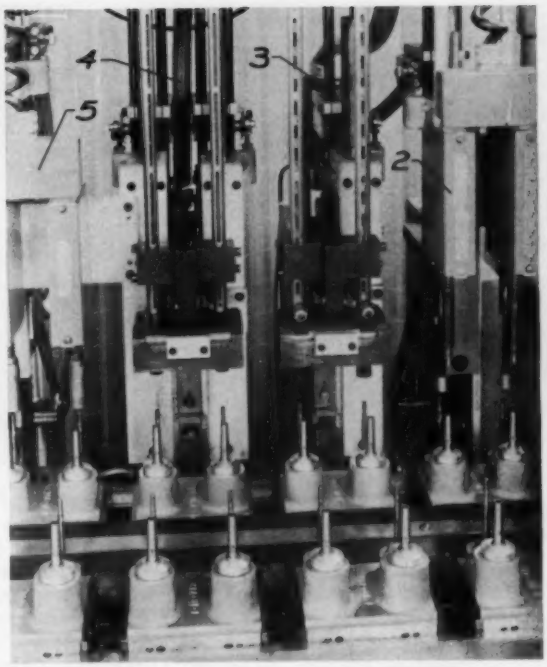
The other two arbors incorporated into the fixture are the "A" arbors over which internal parts are loaded. It is to be noted this is the arbor design which was developed in the cost reduction program on the over-all cap assembly mentioned in Mr. Grumich's earlier discussion.

This machine is a free fixture machine—that is, the fixtures themselves are entirely unattached to any moving mechanism. A set of reciprocating and oscillating fingers merely transfers the fixtures along, and they are shot pinned into position at each station. Should any repair be required at any time, a



3

Rear view of machine shows arrangement of workstation actuators, parts feeders, and hydraulic power unit for pressing operations. This layout is designed to permit convenient servicing of parts supplies.



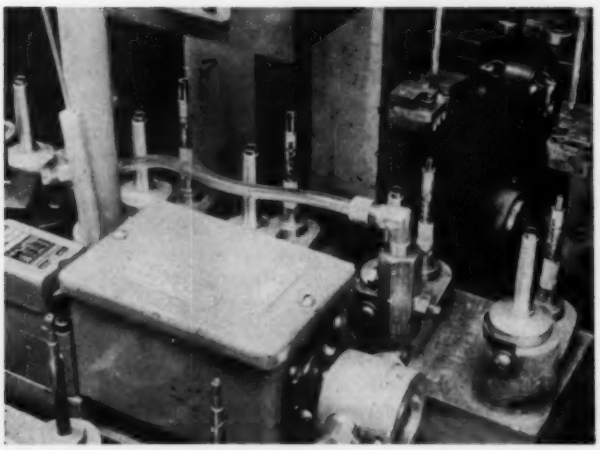
4

After the fixture is cross-transferred to the automatic side of the circulating loop at Station 1, it is checked by probes at Station 2 (right). The probes check to ensure that the "A" arbors are empty and that the "B" arbors hold caps in proper position. At Station 3, ratchet frames fed in oriented position from a hopper are placed on the "A" arbors. All loading motions incorporate a 100 per cent overtravel feature to prevent damage in case of a jam. In Station 4 the springs are fed down tubes and loaded in similar fashion on the "A" arbors. Station 5 is another checking station. Several checking stations are used to prevent excessive loading of good parts on defective assemblies. This system also helps the operator easily spot malfunctioning stations.

fixture may be removed, and a spare fixture inserted in its place. If desired, the fixture may be left out of this circulating system entirely, and a checking system will automatically prevent the loading of parts in the fixture space.

▶ Production Proving

A very important part of the design and build of any automatic assembly machine is the production proving phase. This is a costly procedure and accounts for a fair percentage of the over-all machine cost. But by this activity you will improve the station efficiencies to the point that the machine becomes a practical production piece of equipment.



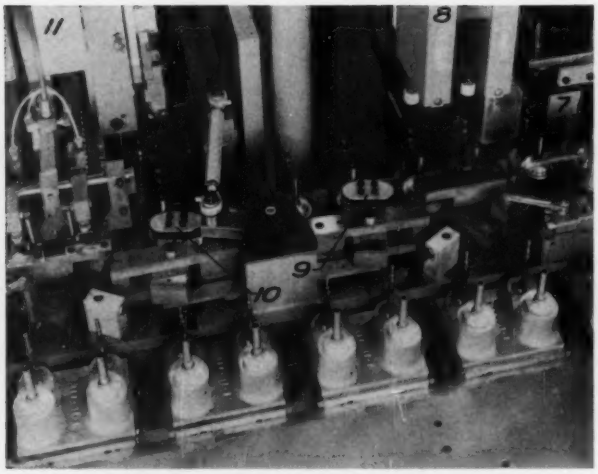
Taking note of the importance of this required high station efficiency operating level. It is well to emphasize the importance of making proper arrangements, during contracting for building of automatic assembly operations, that parts made on production tooling be agreed to be supplied to the assembly machine manufacturer. Production proving at the machine manufacturer's plant is by far the most effective arrangement.

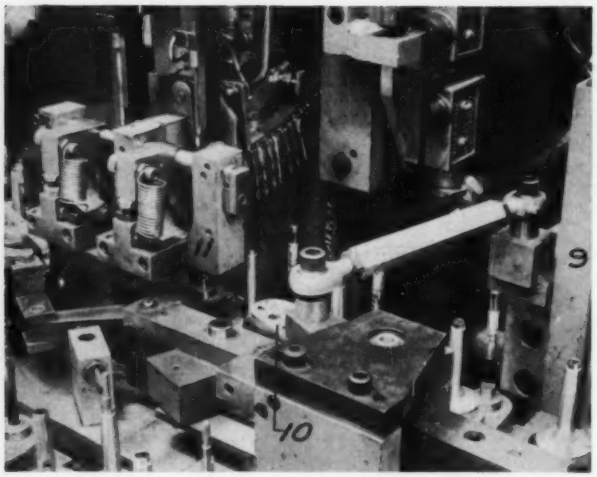
The quantities considered should never be less than 5000 or 10,000 and if possible up to 100,000 to 200,000. This permits selection of parts from all sets of tooling, and experience will be gained on maximum tolerance variation. Experience must be gained with part burr conditions, foreign materials in parts, etc. to make adequate provisions for maintaining part flow —the arteries of the machine.

It is even recommended that if possible the vendor run the customer's required production on the machine several weeks before shipment and include contract arrangements for this work. This pen cap machine ran 150,000 assemblies before shipment and required only a few days to install and become operational.

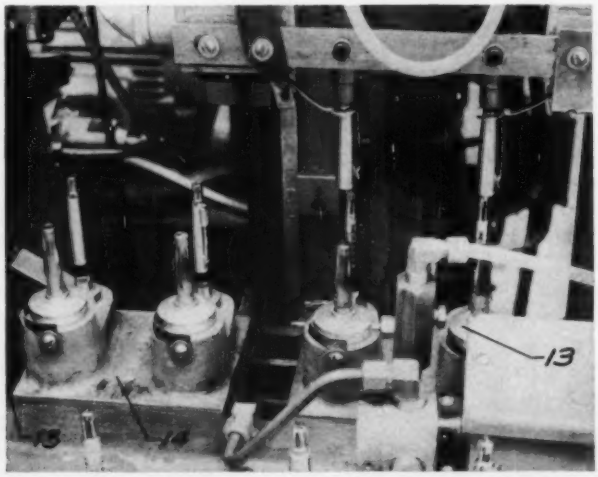
5

Tooling in Station 6 (at right) loads plungers on the "A" arbors. Plungers are fed from a hopper along two tracks. In placing them, probes are inserted through the two plungers so that a closed mechanical circuit conveys the parts to their proper positions. The domes are loaded on the "A" arbors at Station 7 by mechanisms similar to those at Stations 3 and 4.

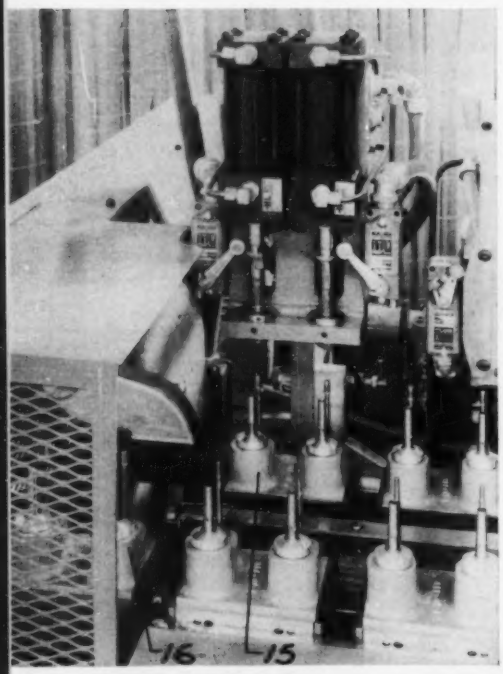




6 Station 8 (at right) is another check station. Probes check for proper placement of the plunger and dome on each "A" arbor. The cap on the right "B" arbor is marked at Station 9, the one on the left "B" arbor at Station 10. Stamping dies are swung through a small arc by an air cylinder and lever arrangement to bring the die into contact with the cap and then away for clearance. So that the cap will rotate a full turn and have proper alignment for clip assembly, a curved rubber pad bears against the cap to maintain constant rate of rotation as gaps in the die lettering interrupt direct die contact. At Station 11 a clip is loaded on each cap on the "B" arbors. As on Station 6, probes are inserted through the parts to guide them into place. Hydraulic units furnish the force to seat the clip over a cap. This completes the loading of all components, and Station 12 is idle.



7 A vertical motion at Station 13 inserts expanding arbors into the upper ends of the caps on the "B" arbors, picks them up, and drops them over the components on the "A" arbors. During the transfer a check is made for the presence of the clip. Station 14 is another idle station.



8 At Station 15 there are two vertical air operated rams, one for each "A" arbor. These presses complete the assembly of the caps. The fixtures are then cross-transferred back to the manual side of the circulating loop at Station 16. Here an inspector unloads the assemblies, gives them a visual inspection, and performs a functional check.

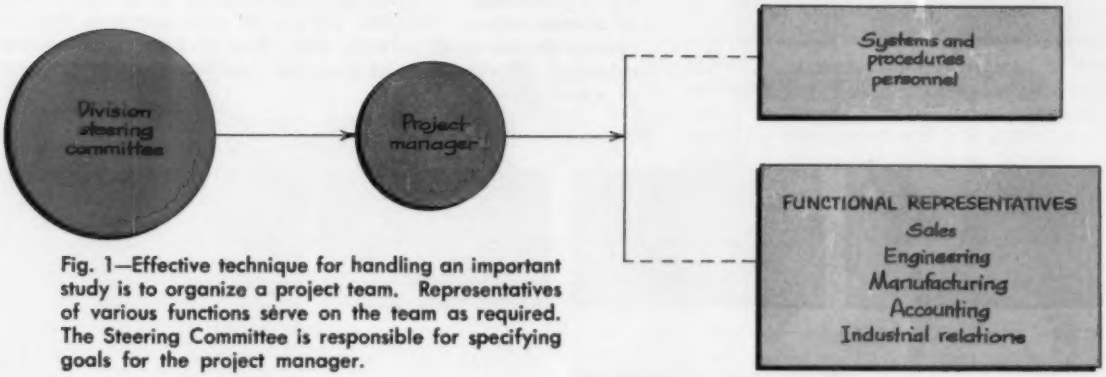


Fig. 1—Effective technique for handling an important study is to organize a project team. Representatives of various functions serve on the team as required. The Steering Committee is responsible for specifying goals for the project manager.

ORGANIZING FOR EFFECTIVE PRODUCTION CONTROL

By **B. W. CURRY**, Administrator, Budget & Planning, Small Motor Div.
Westinghouse Electric Corp., Lima, Ohio

A CRITICAL factor in obtaining improvements in administrative data processing systems is the way a company conducts its feasibility study. The nature of the problem dictates that the investigation transcends traditional organizational boundaries since often the ideal solution lies in the reshuffling of parts of the organization to obtain a more efficient use of data. The experiences of the Small Motor Div., Westinghouse Electric Corp., in obtaining an improved production control system illustrate an effective approach to updating an administrative system.

At the time the improvement study was initiated, the division, involving four separate plants, used punched cards extensively in generating inventory financial reports, shop orders, manufacturing information, and order requirements. Manual techniques were used by the production planning function, located at division headquarters, in preparing weekly manufacturing schedules. The separate plants of the division were tied into the headquarters location and a customer service function by a teletype system. This teletype system was used in the transmitting of daily operating data and shipping instructions, and for limited communication purposes.

In reviewing this existing program for improvement of control, it was decided to develop a system that would use available advanced data processing equipment. To accomplish this, a division steering committee, which still exists, was established. The committee governs the over-all system and procedures activities of the division. Individual projects are presented to this committee along with the evaluation and recommendations of the data processing function, and it is the responsibility of the steering committee to see that the approved projects are carried out.

To provide for the study, installation, and follow-up on the program for improved control, there is a project team under the direction of a project manager. He is assisted by data processing personnel and representatives of the various functions involved who serve as contacts in the case of any question involving their area, *Fig.* 1.

This project team was originally charged with these three objectives: 1. To increase management effectiveness by providing a better end product of over-all clerical effort, as well as reduce the cost of paperwork. 2. To promote greater co-ordination of systems and procedures within the division from the broad, interdepartment viewpoint, as well as intradepartment. 3. To establish techniques of administrative flow that will best carry out management action without regard to the traditional responsibilities.

These objectives were broad and far-reaching in their impact and implication but were not unreasonable. Real reductions in costs could not come from generating more and more information faster, but by the simple expedient of selecting only those items which require action and providing the necessary facts to the proper level of management, quick-

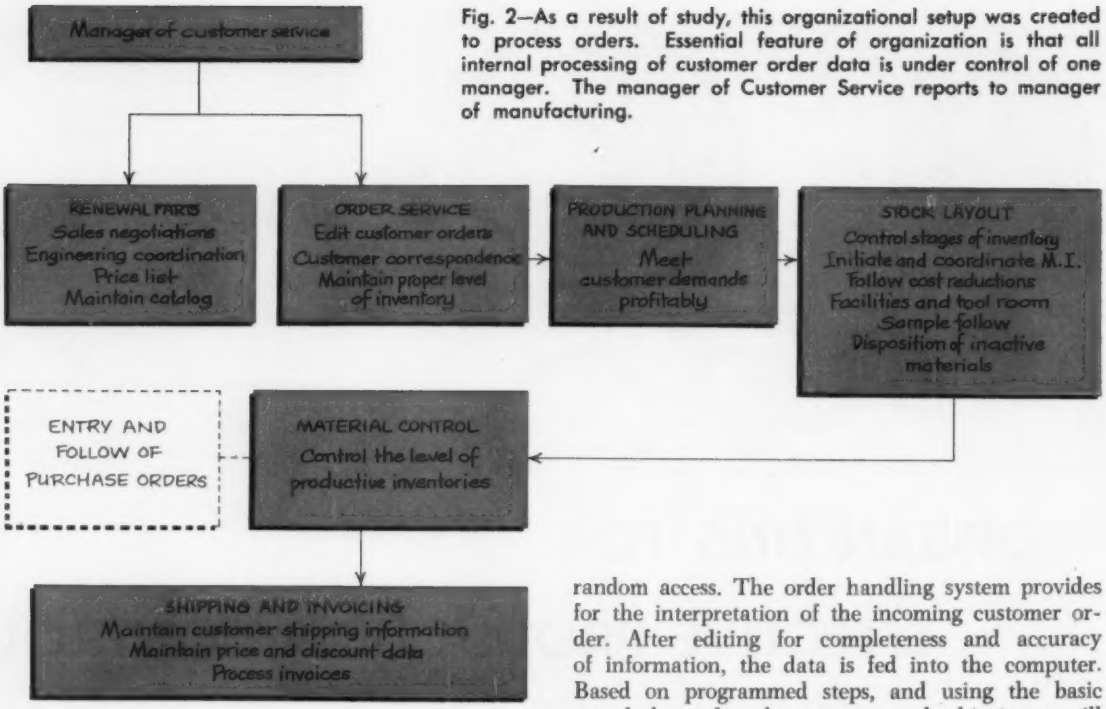


Fig. 2—As a result of study, this organizational setup was created to process orders. Essential feature of organization is that all internal processing of customer order data is under control of one manager. The manager of Customer Service reports to manager of manufacturing.

ly. Just as rapidly, these decisions should be communicated to the area where action would be required. This could only be done by eliminating the long lines of communication which exist only because of tradition. This meant that existing operations, if not required, would not be continued. Where new functional arrangements were necessary, they would be established.

Planning of the improved system was built around the concept of *customer service*. It was desired that an integrated operation handle the order from time of receipt through planning and scheduling to the ultimate shipment and invoicing of the product (motors), as well as maintain control of material and finished goods while in inventory. To accomplish this, a customer service department was created, *Fig.* 2. This function reports to the manager of manufacturing. The manager of the customer service department has the full responsibility for order service, renewal parts and stock control, production planning and scheduling, material control, stock layout, manufacturing information, and shipping and invoicing.

It can be seen that, although not spelled out specifically, this function has the full responsibility for the control of all inventory. Purchasing works closely as a part of this team but is a separate function reporting to the manager of manufacturing.

To complement the customer service organization, an integrated data processing system has been designed in line with the objectives of the program, *Fig.* 3. The basic tool of the system is an IBM 305 Ramac unit which has the capacity to store large quantities of data on discs and the capability of random access. The order handling system provides for the interpretation of the incoming customer order. After editing for completeness and accuracy of information, the data is fed into the computer. Based on programmed steps, and using the basic stored data of each master record, this input will trigger off the many facets relative to the customer order.

In those cases where stock is available, the stock balance is updated. The specific shipping instructions are prepared and the invoice written, taking into consideration all the particular terms applicable to that customer, entirely automatically. If an order review point is broken, the information required to take proper action is generated. This data will be fed back into the computer for the generation of requirements, and, where necessary, purchase orders are prepared for the requisite material. Also, shop orders are prepared for manufactured parts. For special apparatus, the operations—as far as the machine is concerned—are the same as for a stock motor.

Within the computer memory the basic stored data can contain 500 digits of information pertaining to a given active account—motors, purchased materials and components, work-in-process, or renewal parts. This master information is broken down into five 100-digit character sectors with provision for "chaining" if required. These sectors are: Breakdown sector, ledger sector, reference sector, invoice and cost sector, and cross reference and consigned stock sector.

Without going into the technical phases of the program, this stored data generates the following information: Material requirements, the shop order, the purchase order, physical and financial inventory control reports, invoices, cost information and analysis, sales records and analyses, and various accounting records.

The greatest advantage of the system in addition to speeding the processing of the customer order is that the output of the computer is, wherever possible, on an exception basis. That is, only that information that requires action is provided to management.

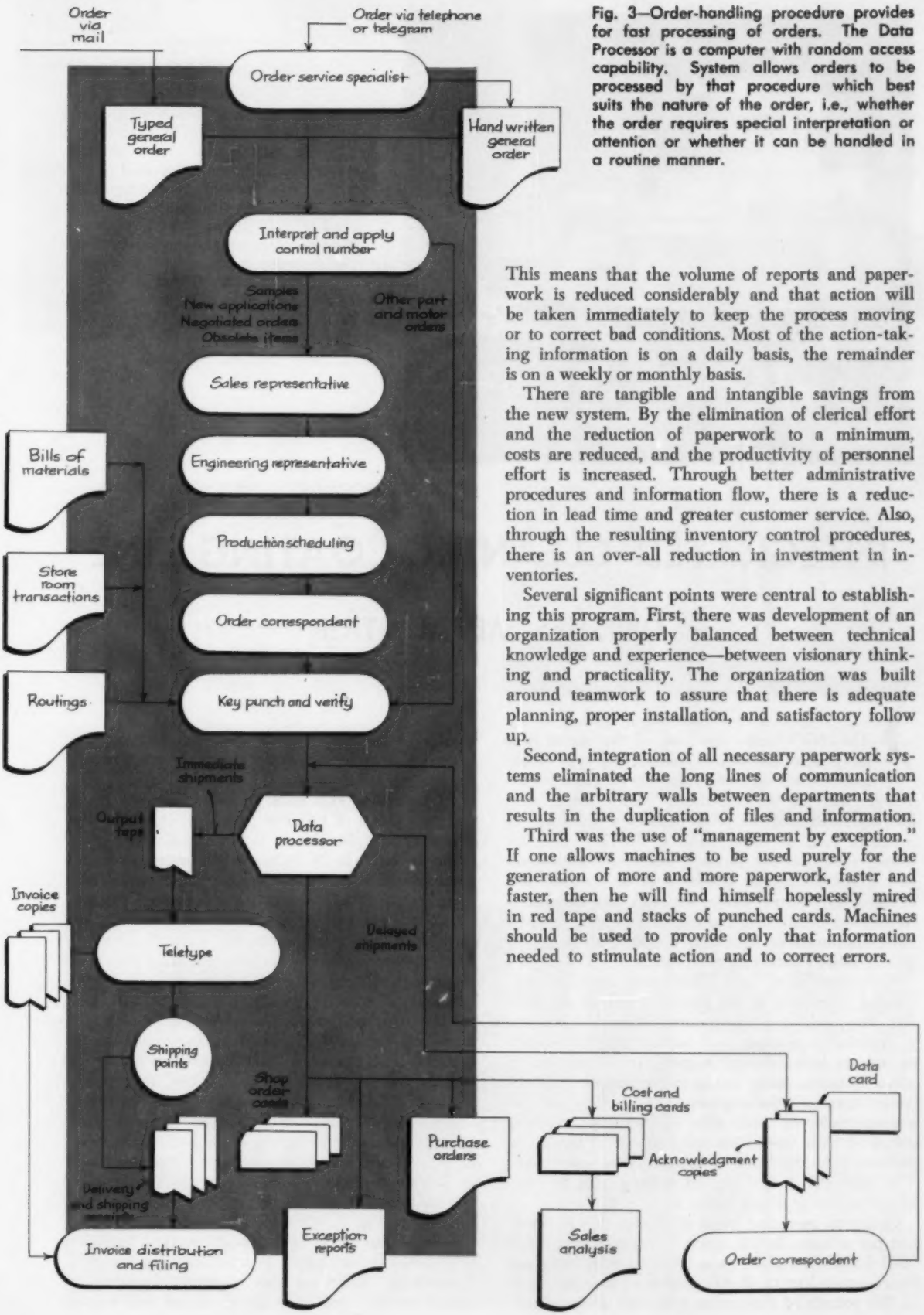


Fig. 3—Order-handling procedure provides for fast processing of orders. The Data Processor is a computer with random access capability. System allows orders to be processed by that procedure which best suits the nature of the order, i.e., whether the order requires special interpretation or attention or whether it can be handled in a routine manner.

This means that the volume of reports and paperwork is reduced considerably and that action will be taken immediately to keep the process moving or to correct bad conditions. Most of the action-taking information is on a daily basis, the remainder is on a weekly or monthly basis.

There are tangible and intangible savings from the new system. By the elimination of clerical effort and the reduction of paperwork to a minimum, costs are reduced, and the productivity of personnel effort is increased. Through better administrative procedures and information flow, there is a reduction in lead time and greater customer service. Also, through the resulting inventory control procedures, there is an over-all reduction in investment in inventories.

Several significant points were central to establishing this program. First, there was development of an organization properly balanced between technical knowledge and experience—between visionary thinking and practicality. The organization was built around teamwork to assure that there is adequate planning, proper installation, and satisfactory follow up.

Second, integration of all necessary paperwork systems eliminated the long lines of communication and the arbitrary walls between departments that results in the duplication of files and information.

Third was the use of "management by exception." If one allows machines to be used purely for the generation of more and more paperwork, faster and faster, then he will find himself hopelessly mired in red tape and stacks of punched cards. Machines should be used to provide only that information needed to stimulate action and to correct errors.

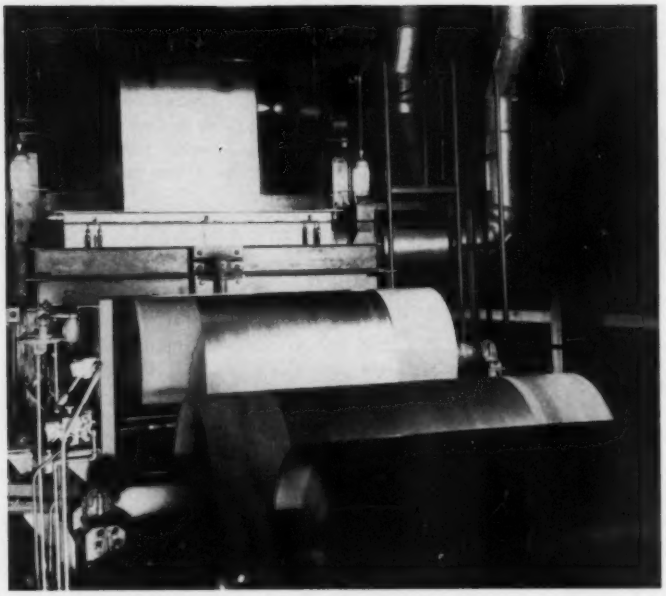


Fig. 1—This view shows the chemical cleaning and treatment section of a continuous metal strip coating line. Three different types of treatment can be applied to protect strip from corrosion and prepare the surface for better adhesion of coating material. Cold rolled steel is prepared by an iron phosphate treatment, aluminum by a chromate process, and galvanized steel by a zinc phosphate treatment. In this view, a 48-inch-wide strip of aluminum is being given a chromate treatment while running at a speed of 150 feet per minute.

INTEGRATED CLEANING-COATING LINE

FINISHES METAL STRIP

TWENTY years ago one of the major uses for prefinished painted metal strip was in the manufacture of metal slats for Venetian blinds. Today, the use of prefinished coated metal strip has expanded into the production of a multitude of products such as water heaters, shelving, building siding, acoustical tile, buttons, instrument panels, oil filters, and aluminum and steel cans. To meet this demand, Litho-Strip Corp., Chicago, has installed a continuous metal strip coating line capable of handling aluminum or steel coils weighing up to 20,000 pounds and in widths up to 68 inches.

Aluminum strip, cold-rolled steel strip, or galvanized steel strip is fed into one end of the 367-foot line and in a continuous cycle of operations is chemically cleaned and surface treated; coated on one or both sides with epoxy, vinyl, acrylic, or alkyd finishes; cured in an oven; cooled; and rewound into coils for shipment. The coating may be a single color on both sides of the strip, different colors on each side of the strip, or one of the many patterns available such as wood grains and linens. The thickness of the applied coating may be controlled to plus or minus 0.0001 inch.

Optimum operating speed of the line is 150 linear feet per minute. At this speed, the system will finish 9000 linear feet of 24-gage, 60-inch wide strip per hour—equivalent to 45,000 pounds of steel or about 15,000 pounds of aluminum. Although designed primarily to handle wide material, the line can also process narrow widths and light gages when matching finishes are required.

In operation, coil stock is unloaded from a coil car onto either of two reel stands having adjustable arbors to fit coils with 16 to 20-inch diameter cores. Cores from 20 to 24 inches in diameter can be accommodated with extensible fixtures. Successive coils are joined to form a continuous web through the line. While the old and new coils are being joined, strip is fed into the line by a four-roll accumulator which holds sufficient material to feed the line for more than one minute at optimum operating speed.

From the accumulator, the strip is fed into chemical cleaning and treatment tanks, *Fig.* 1, where it passes through a five-stage cycle. In succession, the material is cleaned in an alkali, rinsed in hot water, surface treated, rinsed in cold water, and passed through a chromic acid passivation bath. The chemical surface treatment used for steel strip is phosphatizing. Aluminum strip is given a chromate treatment to protect the surface against corrosion and to provide better adhesion for the paint coat.

The treated strip is next drawn across the first roll coater, *Fig.* 2, where paint is applied to the top surface of the strip. At this position, two heads are provided so that colors can be changed quickly. Immediately following this position, the strip is coated on the underside by a second roll coater.

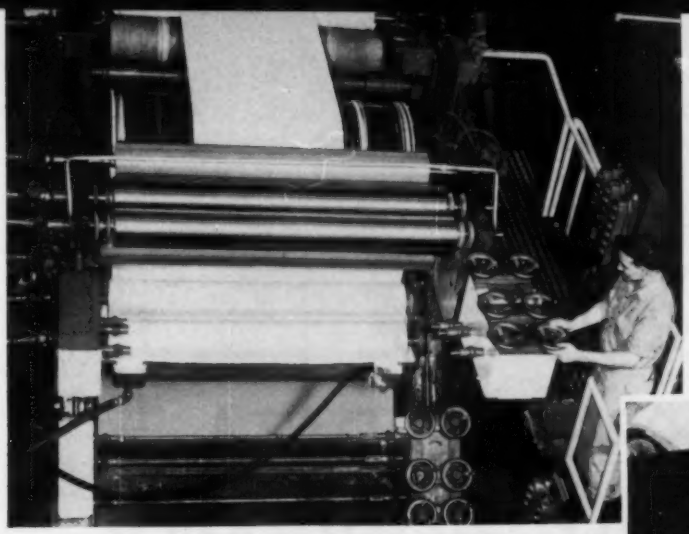


Fig. 2—After cleaning and surface treatment, the strip is run through the coating unit shown. In the foreground is a two-head position where the strip is coated on top. In the background is a single position that coats the underside of the strip. The coating positions can apply the same colors, different colors, or patterns such as wood grains and linens. A recirculating paint system is used in conjunction with the coating positions in order to maintain accurate viscosity control.

The two sides of a strip may be coated with the same or different paints without recourse to any mechanical adjustment to the line.

The coated strip is then run through a gas-fired oven, *Fig.* 3, where it is cured by baking at high temperature. After leaving the oven, the strip is cooled by cold water spray, air dried, and fed into a second accumulator, *Fig.* 4. This accumulator is similar to the first unit and allows more than one minute for a full coil to be sheared and the leading edge of the strip to be hooked into a new rewinding reel.

Strip material may be treated and coated on the line in specified widths and then shipped, or it may be slit to order following the treatment and painting cycles. Where specific products require smooth, painted edges, such as in drapery hardware, other facilities are available for edge rolling and edge coating. In addition, three smaller coating lines that process metal strip from coils are installed parallel to the major line.

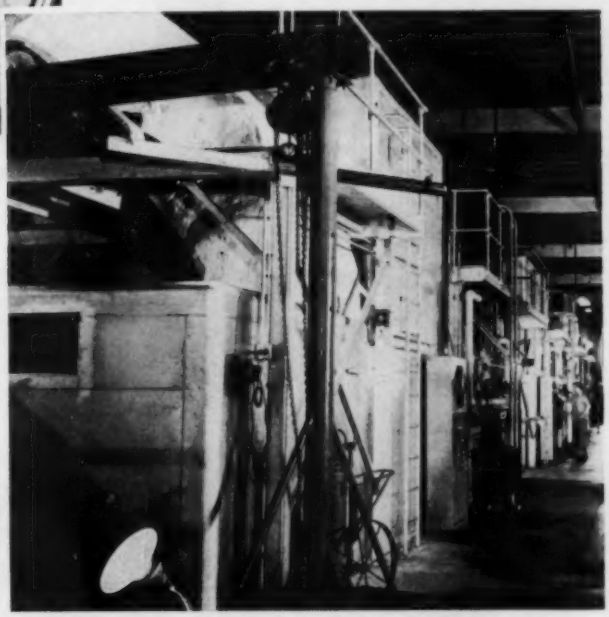


Fig. 3—Coated strip enters the 120-foot long curing oven through the port at the left and may be in the oven from 40 seconds to 3 minutes, depending upon strip speed. Running speeds and temperature (350F to 800F) depend upon the composition, width, and thickness of the strip; the composition and thickness of the coating; and other factors.

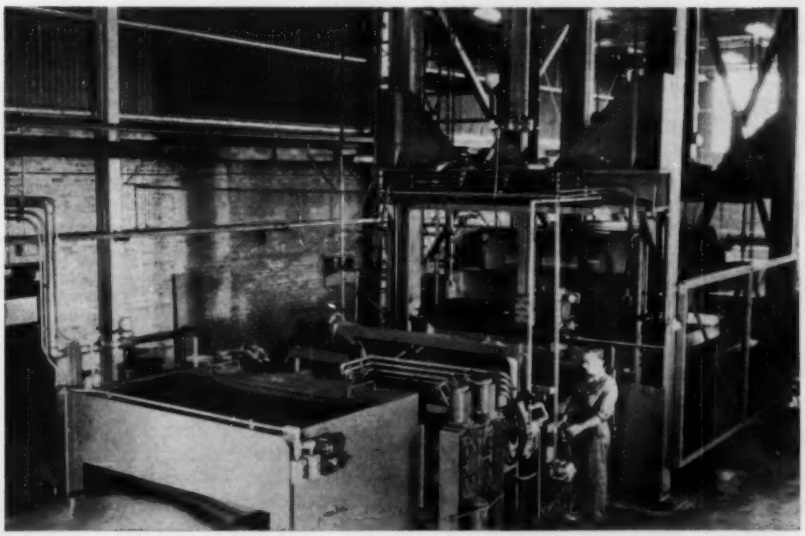
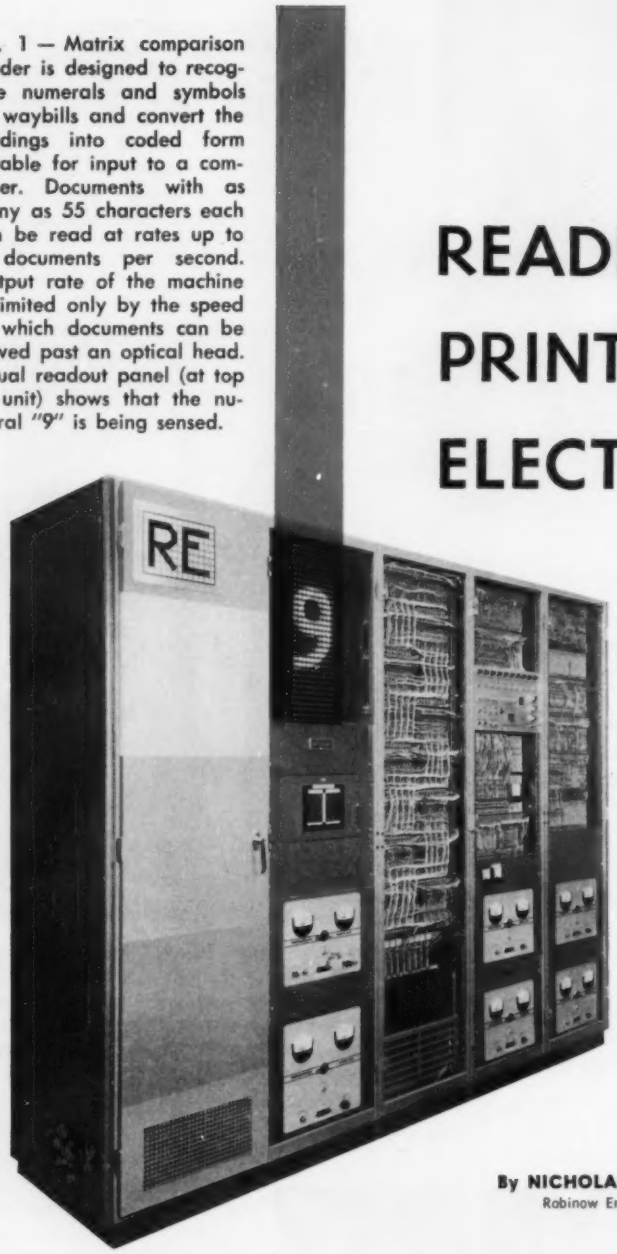


Fig. 4 — Emerging from the oven, the strip is passed through a cold water spray unit, lower left, and then to the second accumulator, right. Squeegee rollers just beyond the spray unit remove excess water. Evaporation from the warm metal makes it bone dry by the time it reaches the accumulator. Shown in the normal down position, the accumulator's elevator mechanism raises the four rolls to take up as much as 216 linear feet of strip during the time the strip is being cut over to a new rewinding reel.

Fig. 1 — Matrix comparison reader is designed to recognize numerals and symbols on waybills and convert the readings into coded form suitable for input to a computer. Documents with as many as 55 characters each can be read at rates up to 7 documents per second. Output rate of the machine is limited only by the speed at which documents can be moved past an optical head. Visual readout panel (at top of unit) shows that the numeral "9" is being sensed.



READING PRINTED DATA ELECTRONICALLY

Stumbling block to efficient utilization of many high-speed data processing systems has been the procedure for converting written information into the coded language required by computers. The author describes basic types of automatic reading machines and details the operation of a matrix comparison unit that can process typewritten or printed documents at high speeds.

By **NICHOLAS E. GOLOVIN,**
Robinow Engineering Co. Inc., Washington, D. C.

ONE OF THE more pressing and difficult problems associated with the introduction of electronic data processing systems is that of finding rapid and economical means for converting information from the numeric or alphanumeric form in which it is usually generated into the coded form digestible by a computer. Thus, if it is desired to automate the processing of records in handling subscriptions for publications, there will be a problem of how to transfer to the computer's memory the information contained in thousands or perhaps millions of metal address plates. Similarly, the day-to-day operations of large transportation, banking, insurance, or merchandising enterprises may daily generate hundreds of thousands of lines (or pages) of alphanumeric data that must be later transferred to computer storage and processing.

Currently, the bulk of such data conversion and transfer is accomplished by human operators using paper tape or card punching equipment. Such processing is relatively slow and comparatively expensive, particularly if high accuracy is required. The major purpose of "character recognition" devices

or "reading machines" as they are usually called, is to eliminate human participation in such data transfer operations with concurrent increased speed and accuracy and decreased cost per unit of information handled.

Approaches to Character Recognition

Technical problems of automatic character recognition have their origin largely in the fact that all printed, typewritten, or handwritten information is normally produced for human recognition. The human eye, in conjunction with the human brain, is a flexible device that can readily interpret symbols which are improperly or poorly reproduced and arbitrarily oriented and located on source documents. Automatic recognition devices have difficulties in precisely these areas. In cases where it is possible to control the design of documents, symbols, and the reproduction process specifically for facilitating reading through automatic equipment, such technical problems become substantially less difficult.

There are two prevalent approaches to character recognition: 1. Analysis of a printed character by its constitutive elements for a logical determination of its identity. 2. Comparison of an individual unknown character with a set of stored standard characters to establish the standard character most nearly like the character being read.

Insofar as the logical analysis approach is concerned, the character is first scanned either mechanically or by a cathode-ray flying spot scanner, with the resulting information being then passed directly to a set of logic circuits or to a storage matrix. In either case, the information is analyzed to determine what component features are present in the character, that is, whether it contains a vertical line, a horizontal line, how many of each and in what sequence, etc. With a sufficiently extensive logical analysis along these lines, the character can be "recognized."

A basic difficulty with systems of this type is that intermediate machine decisions about character features are made on the basis of partial data. If scanning is performed mechanically, attainable reading speeds are substantially lower than with electronic scanning.

Another type of machine falling into the first, or logical analysis, class is based on electronic curve tracing. In such devices the character elements are either traced by a spot of light (generated by a cathode-ray tube, for example) or by a radar-type tracing technique. The directions in which the character elements go are then recorded, and the character is recognized by the sequences and lengths of the curve-traced character elements. No practical commercial machine of this type has yet been built, although a great deal of work has gone into research on this technique. This type of machine may become particularly suitable for reading hand-printed or hand-written characters. It has the theoretical attribute that size and exactness of shape of a character are of relatively low importance in the recognition process, so that similar characters of various sizes can be read through identical logical circuits.

The second approach, involving establishing the degree of match between a given character and a set of stored standard characters, is often referred to as the "map match technique." Its oldest variant is purely optical matching.

In a machine of the map match type, a printed character to be identified is optically projected onto a set of photographic masks, behind each of which is one or more photocells. The degree of match between the projected image and the known negative or positive can then be quantitatively estimated in terms of photocell outputs.

Such machines suffer from major difficulties in positioning and speed. The procedure can be improved somewhat by scanning the resultant of the superposed image and using an "optimum match" technique. However, there are reasons to believe that this technique is not likely to develop into a major tool for practical, high-speed data processing where great flexibility of operation is desired.

Modern variants of the optimum match method in-

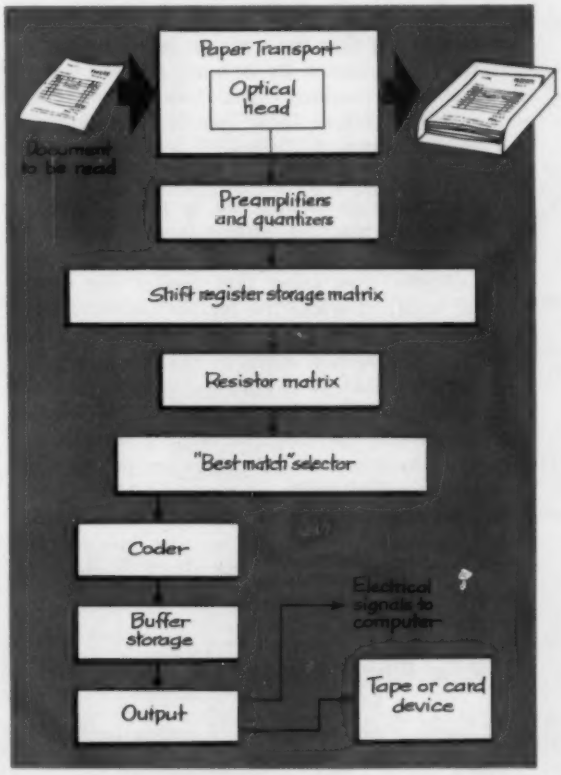


Fig. 2—Block diagram illustrates the major elements of a matrix comparison reader. System provides coded electrical signals representing each character scanned on a document. Output may be fed directly to a computer or it may go to intermediate storage on punched paper tape, punched cards, or magnetic tape.

volve conversion of optical character signals into electrical outputs which are subsequently compared with stored electrical representations of standard characters. From the comparison, a quantitative measure of the best match is obtained. This principle is used in magnetic ink character readers developed for the American Banking Association. Another machine using the principle, but which does not require the use of magnetic ink, is the Rabinow Universal Reader (RUR), *Fig.* 1, developed by Rabinow Engineering Co. Inc. This unit falls into the general class of character recognition machines known as "matrix comparison readers."

Matrix Comparison Technique

A block diagram of a Rabinow Universal Reader is shown in *Fig.* 2. In operation, documents are fed one at a time under an optical head by a high-speed paper transport. The paper may be moved past a single-line scanner, a page scanner, or a short-line-on-tape scanner, depending upon the type of document being read. Images of each moving character in the document are projected by the optical head and sensed by a bank of photocells in the head. The resulting signals are then amplified and quantized before being passed to a shift register storage matrix.

After it has been shifted to a standard location, the information in the register is used to drive a set of resistor matrices (there is one matrix for each numeral and letter of the alphabet). Recognition circuits then select that one of the resistor matrices which provides the highest output voltage, indicating the "best match" to the character just scanned. The selection made by the recognition circuits is next coded in any desired binary code and transferred through a buffer storage to an output. The output may be fed directly to a computer or it may go to intermediate storage on punched paper tape, punched cards, or magnetic tape. Details of the essential character recognition elements and their operation are given in the box entitled "Character Recognition by the Matrix Comparison Method."

Reliability in Recognition

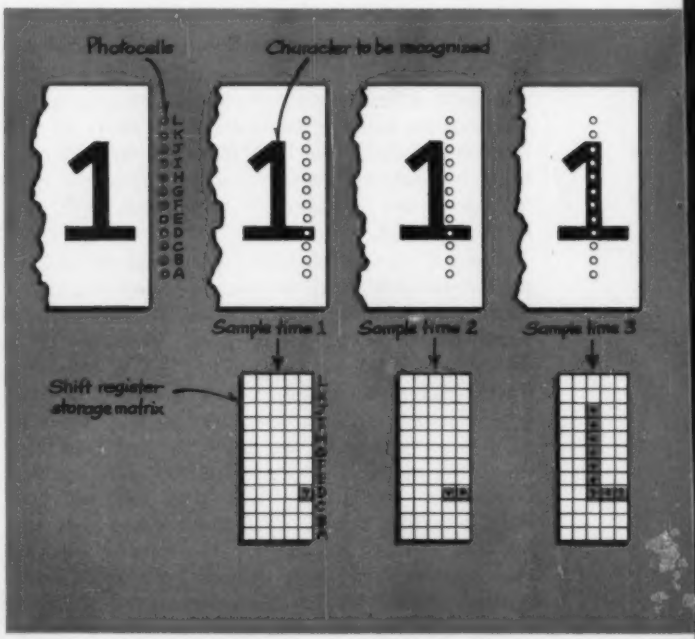
To improve the reliability of matrix comparison readers, additional requirements can be imposed beyond simply recognizing the best match. With a so-called "doubles" reject technique, for example, an observed character can be rejected as uncertain if the two highest voltages in the recognition matrix set are too close to each other. Then, by adjusting the relative values of acceptance or rejection voltages, recognition can be made as error-free as desired by simply increasing the proportion of rejected characters. The reject percentage can also be made smaller at the cost of a higher proportion of errors. The choice would depend on the font being read, the significance of errors in the input material, and the cost of reprocessing rejects.

In usual applications, the recognition level is set to maintain the error rate as low as possible. Provision can also be made to print a mark indicating on which line of the document each reject occurs so that these lines can be reread by other means or fed through for another recognition try by the machine.

CHARACTER RECOGNITION BY THE

In the Rabinow Universal Reader, characters on an input document are brightly illuminated as they pass beneath an optical head. An image of the field of view is projected onto a stationary column of photocells as shown in *Fig. a.* In this illustration, the image of a single character is shown as it moves from left to right past the column of photocells. As the character moves, reflected light picked up by the column of photocells is converted into electrical signals.

A reading cycle is begun when the first dark portion of an image is sensed by any of the photocells (as in *Sample Time* 1, *Fig. a*). When this occurs, circuits are alerted, and gating cycles begin. Since the speed at which the document is being moved is known, the character can be examined at specific time intervals. In the diagram, five time samples are shown. The choice of this number was made for pictorial simplicity; the actual number of time samples used in a given application depends upon the resolution required to recognize the characters involved.



There are other procedures available for improving the reliability of the over-all recognition system. For example, one machine reads a standard, preprinted alphabet between every two documents presented to it, thereby checking the machine's accuracy before beginning the next document. This provision does not completely guarantee that the machine will not make an error in reading the document, but it does provide assurance that the machine is functioning correctly not more than five seconds before it starts reading. Furthermore, the check alphabet can be printed in both very heavy and very light density ink, so that the tolerance of the machine can be continuously checked.

If a field containing only numerals is being read, the alphabetical part of the machine can be temporarily disabled electrically so that only ten voltages have to be compared against each other. Limiting the range of choice for recognition in this way appreciably decreases both the reject and error probabilities. Furthermore, through appropriate use of peripheral equipment the recognition procedure can be programmed so that if there is something unique about a line, or part of a line, advantageous use can be made of this knowledge to correct errors occurring in the input documents or those made by the machine. For example, if addresses are involved in the input documents, it is likely that most of

MATRIX COMPARISON METHOD

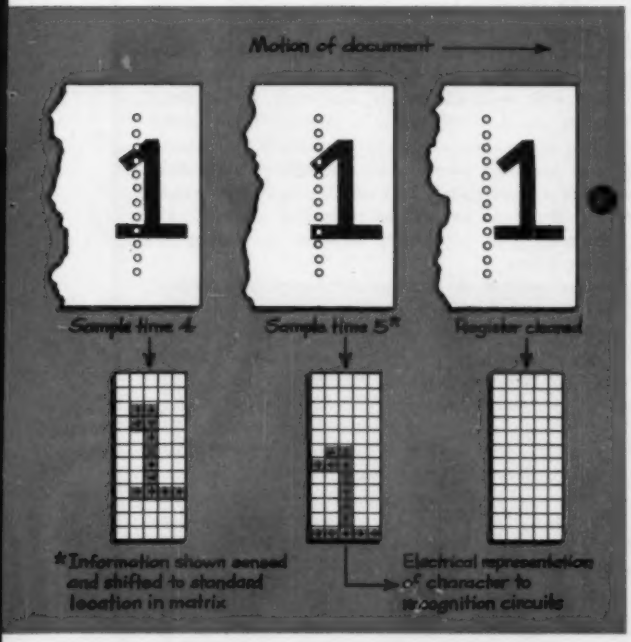
As the image continues to move past the photocells, successive samplings provide additional outputs from the photocells. The outputs are amplified and converted into "quantized" signals that are loaded into a shift register storage matrix as shown. In quantizing, the electrical outputs of the photocells are converted into discrete levels.

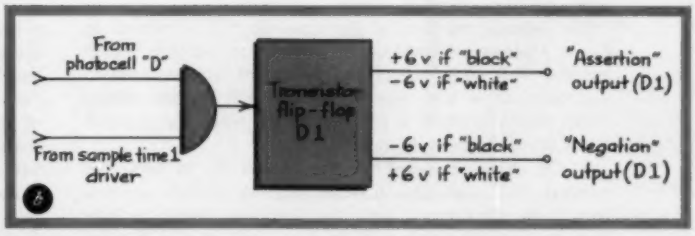
The number of quantizing levels chosen in a particular case is a function of the difficulty of reading the material involved. For example, where a document is uniformly white and the characters are definitely much darker, two-level quantizing that distinguishes between the "white" and "black" states is satisfactory. For more difficult material, four-level quantizing may be required in which the levels correspond to "white," "light gray," "dark gray," and "black." Photocell response is then adjusted so that different percentages of reflected light correspond to different shades between white and black.

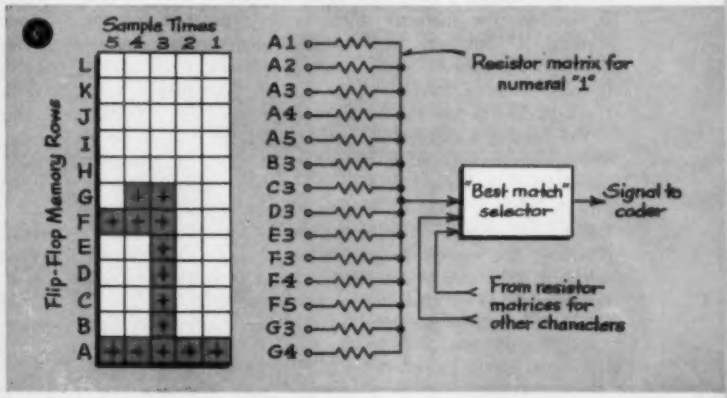
The quantized signals from the amplifier are loaded into the shift register storage matrix at intervals corresponding to each sampling time, *Fig. a*. In a complete sampling cycle, each horizontal row of the storage matrix can be fed by one photocell.

The state of the shift register storage matrix after each sample time is shown in the illustration. For example, the matrix representation for *Sample Time* 1 shows that photocell *D* has transmitted a signal for storage in the righthand vertical column of the matrix. The other photocells in the optical head did not place signals in storage at this time because they did not receive dark portions of the image being scanned. At later sampling times, additional photocells assist in forming a complete, stored electrical image of the character. Sufficient photocells and memory rows are provided to sense and record the tallest character in a document and to accommodate variations in the vertical positions of the characters.

After a character being read has passed the column of photocells, the information in the shift register storage matrix is electronically shifted to a standard position at the lower portion of the matrix. This operation requires


Motion of document
Sample time 4
Sample time 5*
Register cleared
*Information shown sensed and shifted to standard location in matrix
Electrical representation of character to recognition circuits




Sample Times
5 4 3 2 1
Flip-Flop Memory Rows
L K J I H G F E D C B A
A1 A2 A3 A4 A5 B3 C3 D3 E3 F3 F4 F5 G3 G4
Resistor matrix for numeral "1"
"Best match" selector
Signal to coder
From resistor matrices for other characters

them will be associated with a small number of large cities and towns. Then the spelling of such locations, as given by the machine, can be checked by comparison with a dictionary of such names stored in the accessory computer's memory. If the error is such that ambiguity in location is actually involved, the computer can be easily programmed to so indicate and, in fact, spell out the error or correct it.

The rate of application of automatic character recognition devices has been increasing rapidly and is likely to grow further. This is due largely to the fact that economies made possible by the use of large data processing systems are often severely limited by the relative slowness and high cost of conventional methods for feeding high-speed computers. Continuing research in developing faster and more efficient automatic character recognition equipment will do much to alleviate this situation. The fundamental elements of the systems described will probably be used in such equipment.

only a few microseconds, and is done to facilitate later recognition of the character by resistor matrix and "best match" selector circuits.

The manner in which signals from the photocells are stored in the shift register storage matrix is of interest. One storage element of the matrix is depicted in *Fig. b*. This unit is shown ready to store information sensed by photocell *D* at *Sample Time* 1.

Assuming that photocell *D* senses "black" at *Sample Time* 1, the flip-flop will be placed in the "black" state, and the outputs labeled "black" will be set up. If "white" is seen by the photocell at this time, the outputs labeled "white" will be available.

Each storage element in the shift register storage matrix provides a choice of two, complementary outputs in the form of equal voltages with respect to ground, but having opposite polarities when the flip-flop is in a given state. The use of the "negation" output will be explained later.

After the information in the shift register storage matrix has been shifted to the standard location, the character stored electrically in the register can be examined. This is accomplished by a series of resistor matrices which are connected to the flip-flop outputs.

The resistor matrix for the numeral "1" is shown in *Fig. c*. Operation is as follows: In order to define a perfect numeral "1," each resistor in the matrix is connected to that terminal of each element of the shift register storage matrix which provides a positive voltage when the numeral "1" is stored in the register.

If the character stored in the register is, in fact, the numeral "1," then plus 6 volts will be applied to each resistor in the matrix and the resulting match voltage from the resistor matrix will be maximized at plus 6 volts. If, however, the character stored in the register is not the numeral "1" but, say, the letter "E," then some of the resistors in the matrix for the numeral "1" will receive minus 6 volts. Thus, a match voltage of less than plus 6 volts (perhaps close to zero volts) will result.

The highest match voltage will always be obtained from that resistor matrix which is connected so as to recognize the character actually stored in the register. Recognition of this character is made by feeding all of the match voltages into a "best match" selector that senses the resistor matrix providing the highest output. When this has been established, a coder can be activated to generate a binary coded signal unique to the character recognized.

Negation outputs are used to distinguish characters that are similar in certain respects. Thus, the matrix for the letter "F" will have four "negatives" and a "positive" along its bottom row to ensure that the character is distinguished from the letter "E" which should have all "positives" in this row.

Another technique used to enhance the difference between similar characters is that of weighting individual matrix elements. For example, consider the problem of distinguishing between the letters "O" and "Q" which have the same shape and size except for the presence of a slight tail in the "Q". Instead of connecting matrix resistors of standard value to the storage elements for points on the tail, resistors of lower value are used. In this way, each point on the tail receives additional weight to reflect the fact that this part of the character is particularly significant for proper recognition. In using weighting techniques, the final determination of which points to exaggerate and which to play down depends not only upon distinguishing between similar characters, but also upon distinguishing each character from all the others.

It is interesting to note that the character recognition system can properly identify characters that are imperfectly imprinted, for example, because of slight smudging of the entire character or partial defects in the ribbon or the printing plate. In these cases, some of the locations which should have been indicated by "black" will be shown as "white" and vice versa. Electrically, the result is that some of the matrix resistors will receive a voltage of the wrong polarity. The over-all output voltage from the proper matrix will then be less than plus 6 volts (perhaps plus 5 volts). However, this reduced voltage will still be the highest match voltage, and the character will be recognized properly. Of course, characters that are grossly imperfect can cause erroneous recognitions.

Other refinements of the basic matrix comparison method include positioning the character first to the bottom and then to the top of the shift register storage matrix. In this manner, two independent recognitions can be made of each character as a check on each other. Where experience shows that some fonts produce characters that are often defectively printed, more than one resistor matrix can be provided for each character. Machines have been built with as many as 112 resistor matrices for a single alphanumeric font. With no theoretical limit on the number of resistor matrices, it is conceivable that a machine employing thousands of resistor matrices could recognize characters of several languages intermixed.

MAKING FROZEN PIES

PRODUCTION of 28,000 frozen pies per day is carried out by 21 employees in one, 8-hour shift at a new plant of Town Square Foods Inc. This output rate, representing more than 1300 pies per employee per shift, is possible because of the use of modern, automated pie making facilities. The equipment is integrated into a continuous processing line.

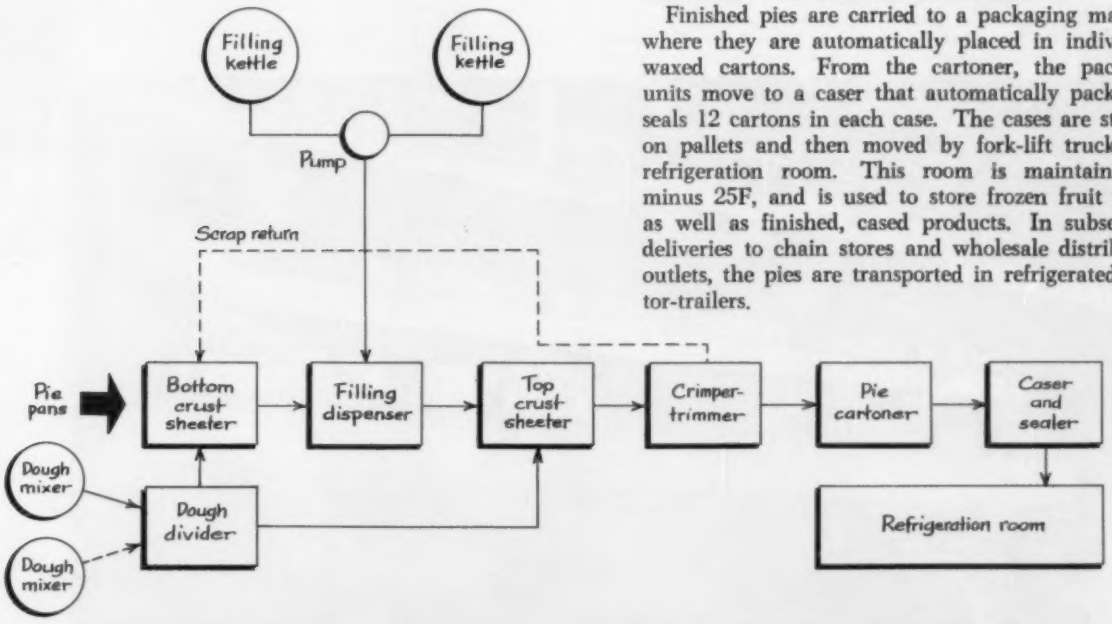
At the beginning of the line, pastry is fed from alternate dough mixers into a dough divider. From the divider, dough balls are fed on belts to top and bottom crust sheeters.

Dough conveyed to the bottom crust sheeter is prepared and placed automatically into aluminum pans moving beneath the sheeter on a belt. The pans are loaded into holders on the belt by an operator.

Pans containing bottom pastry next move to a filling dispenser. Here, fruit filling is automatically dispensed onto the pastry in each pan. The filling is pumped to the dispenser from two, 200-gallon kettles.

In the next operation, pans containing bottom pastry and fruit filling are moved beneath the top crust sheeter where a top crust is placed on each pie. The sheeter is supplied with dough by one of the two belts leading from the dough divider. Pies then continue to a crimper-trimmer which crimps the top and bottom pastries and trims off the excess pastry around the edges of each pan. Excess material that has been trimmed off the pies is returned on a conveyor to the head end of the line where it is used for bottom crusts.

Finished pies are carried to a packaging machine where they are automatically placed in individual, waxed cartons. From the cartoner, the packaged units move to a caser that automatically packs and seals 12 cartons in each case. The cases are stacked on pallets and then moved by fork-lift truck to a refrigeration room. This room is maintained at minus 25F, and is used to store frozen fruit filling as well as finished, cased products. In subsequent deliveries to chain stores and wholesale distribution outlets, the pies are transported in refrigerated tractor-trailers.



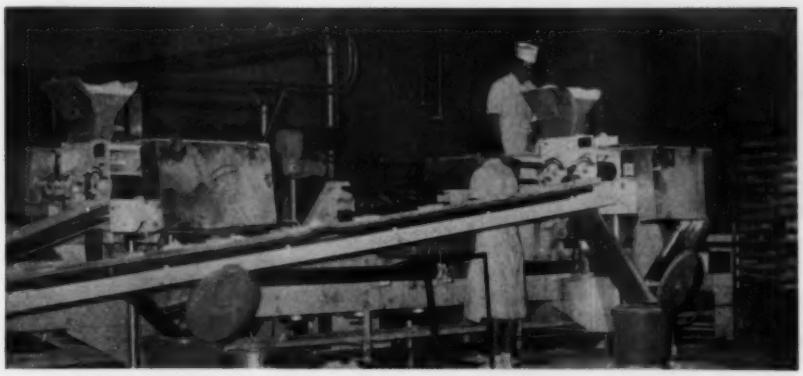
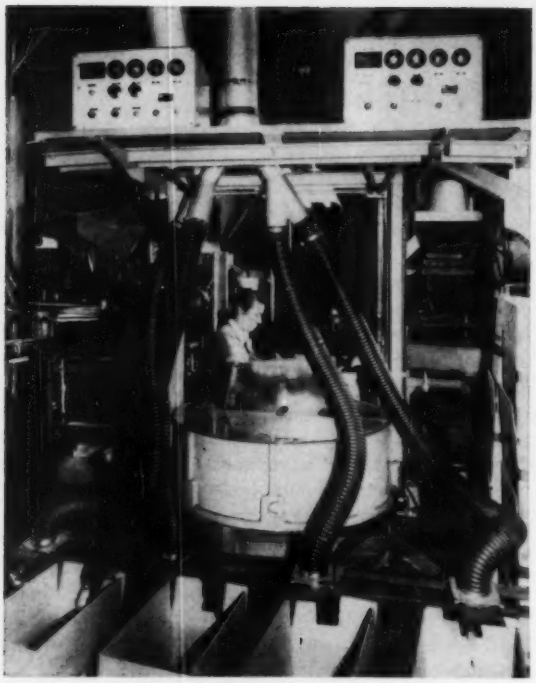
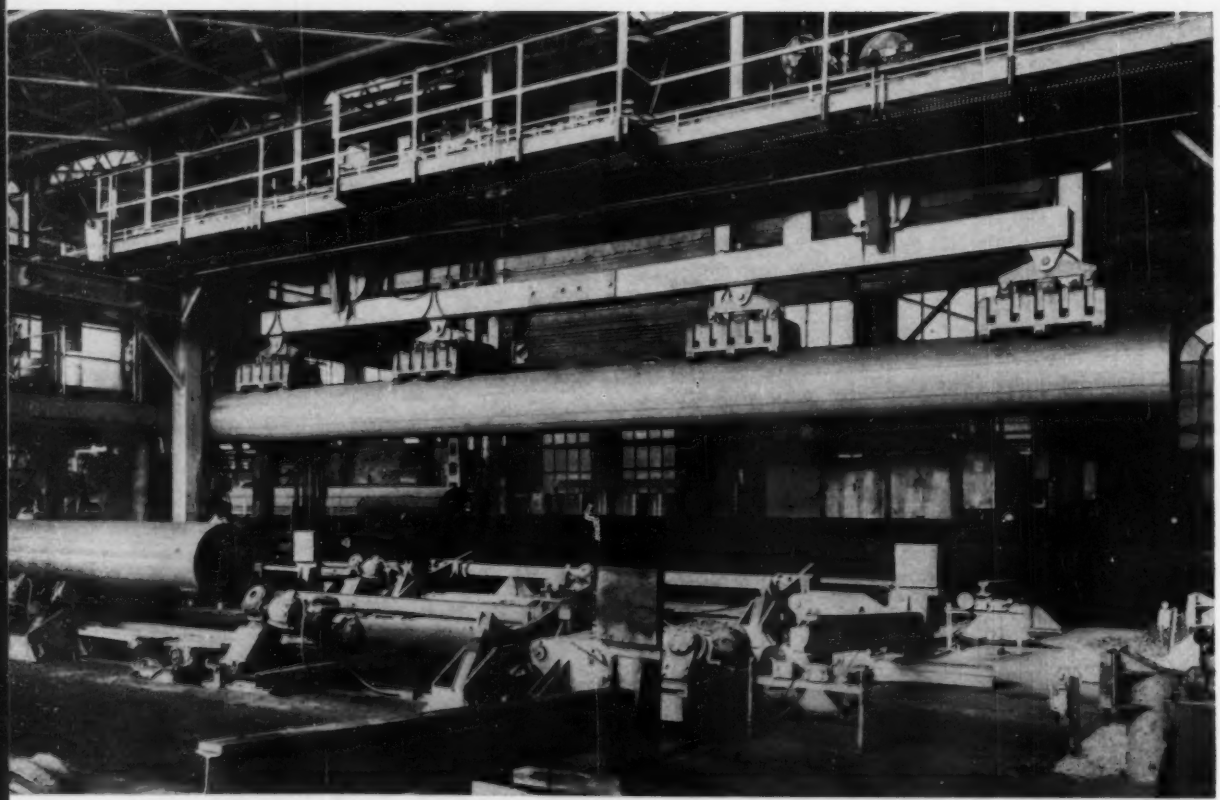


Diagram illustrates major units of integrated line for manufacture of frozen pies. Photo shows a portion of the line. Large units with hoppers are crust sheeters that prepare and place bottom and top crusts in pans moving on a conveyor. Pipes in background, between sheeters, carry pie filling from two kettles to a filling dispenser that adds filling in the proper sequence. Machine to left of operator at floor level is a crimper-trimmer.



Packaging Bottle Caps

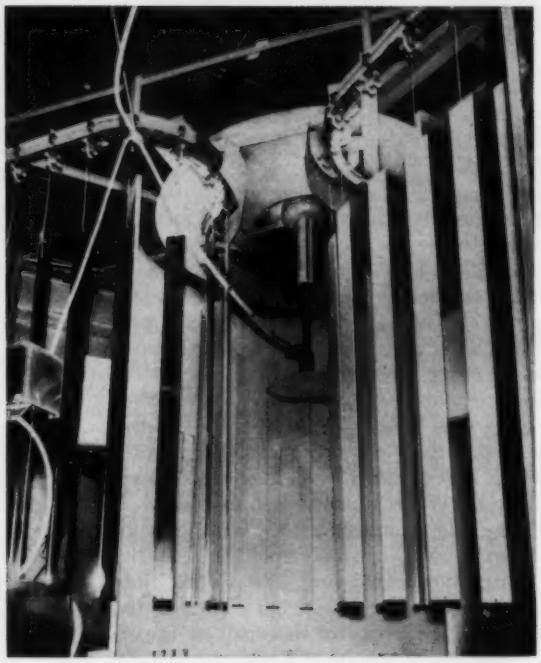
SYSTEM to package bottle caps by count has been installed at Mundet Cork Corp. Completed closures move on a conveyor belt past the inspector in center background and into the large drum-like hopper at center. Forked chutes at left and right sides of hopper carry the caps by gravity into cartons in the foreground. As caps pass from the hopper into a chute, they interrupt the beam to a photoelectric eye and impulse an electronic counting mechanism supplied by Veeder-Root Inc. One counter controls each forked chute, and the two counters are mounted at top. When the proper count is delivered to a carton, a diverter in the chute is flipped to direct caps to the other carton. Flexible hoses over the cartons supply cooling air to cool the caps.

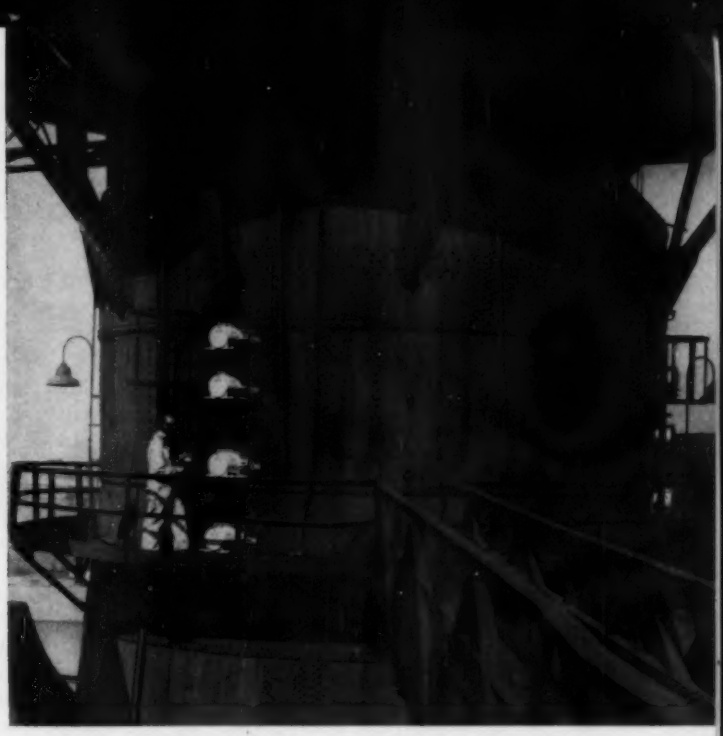


Transferring Pipe

LENGTHS of welded pipe 40 feet long are automatically transferred from three welding lines to one conveyor leading to the pipe testing station at the Steelton Plant, Bethlehem Steel Co. Controls supplied by EC&M Div., Square D Co., direct the handling operation. An automatically controlled overhead crane uses electro-magnets to transfer pipe from two of the welding lines; pipe is rolled from the third line to the test station conveyor. Pipes ready to be transferred actuate signal devices, and a memory system controls transfer in the order of availability. Power to the electromagnets and operation of the hoist motor are controlled automatically.

in action





Gaging Burden Level

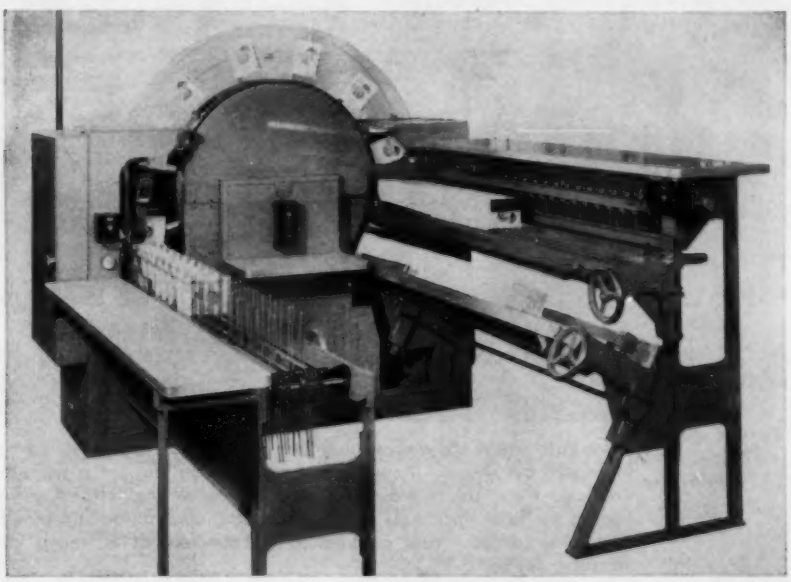
SENSING of burden level in blast furnace at Republic Steel Corp. is performed by nuclear gage system developed by their Electromechanical Research Center. The operator is shown checking for stray radiation from one of the four gamma-ray emitters directed through the furnace at four different levels from one side. Three other emitters are directed through the furnace from the right. An individual detector across the furnace from each emitter senses when the stock level drops below its radiation beam. Cutler-Hammer Inc. will manufacture and sell the devices.

Painting Light Fixtures

PARTS for fluorescent lighting fixtures are automatically painted at Sta-Brite Fluorescent Mfg. Co. Parts to be finished are carried on an overhead conveyor through a washer and dry-off oven, cooled for 5 minutes, then painted as they move around the loop shown in the electrostatic spray zone. The electrostatic spray system supplied by Ransburg Electro-Coating Corp. uses a 25-inch rotating paint disc which reciprocates vertically, and the work hangers rotate the workpieces to obtain even coating.

Interleaving Greeting Cards

HIGH-speed machine used in plants of greeting card manufacturers tucks envelopes into the flaps of folded cards at a rate of over 20,000 per hour. Rotating blades pick up envelopes and cards at right and deposit the assemblies at left. Belts advance envelopes and cards at the feed stations, and pneumatic suckers separate the paper stock to allow blade insertion. Interleaved cards are deposited in groups of predetermined count between rods on the moving chain at the output station. Pearce Development Co. built the unit.



SHEETING LINE INCLUDES AUTOMATIC INSPECTION

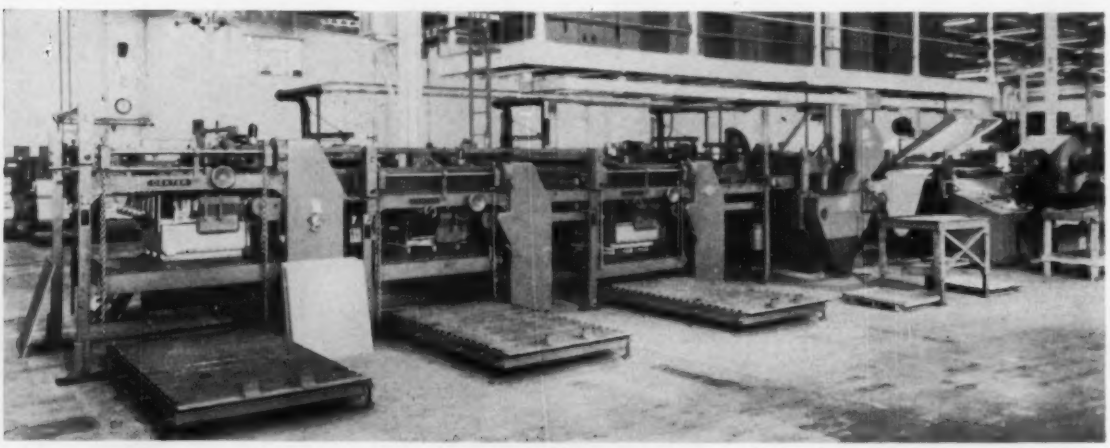
ONE PHASE of maintaining product quality is to cull defective or substandard materials before they are processed into products. In many cases this culling must be accomplished in the user's plant since it is economically infeasible for the material supplier to do so. A case in point is the inspection, shearing, and sorting of tinplate and aluminum strips at the Crown and Closure Div., Crown Cork and Seal Co. Inc., Baltimore, Md.

Two automatic inspection, shearing and sorting lines have been installed at this plant to cull material which is under or over gage or has visual defects, and/or pinholes. One of the lines is shown in the accompanying photograph. In operation, coiled strip is loaded onto an unwind stand and fed through a leveler and past a thickness gage. If the gage detects a section of the strip that is either over or under standard, it electrically actuates a memory device. Later, when the strip is cut into sheets, the memory device causes the defective sheet to be collected at a reject piler station.

Once past the thickness gage, the aluminum or tinplate strip moves through a visual inspection station which has mirrors both over and under the moving web. If the line operator notes any visual defect, he presses a button on the control console and causes the memory device to be actuated so that the sheet will be rejected when piled. The strip then is moved through an automatic inspection station where the web undergoes a check for pinholes. Light is projected onto the web and actuates the memory device when a pinhole allows the light to pass through the web and energize a photoelectric cell.

The moving strip is next cut by a reciprocating shear. Immediately beyond the shear is an elevated tray which permits the operator to deflect and remove a sheet from the line for closer examination. Finally, the cut sheets are delivered to one of three pilers. The pilers may be used interchangeably and were built by the Dexter Co. Division of Miehle-Goss-Dexter Inc. During operation, two pilers are in use—one for acceptable sheets and one for rejects—while the third piler is being unloaded and readied for a new load. Each piler includes an elevator platform which indexes downward as sheets are collected on a skid. When the skid is fully loaded, it is rolled off the piler platform onto a stand-by conveyor for later removal by fork truck.

The two inspection, classifying, and sorting lines replace a manual inspection system. Under the old method, when an inspector detected an imperfection, he would signal a man at a piler who would place a tag in the pile to mark the location of the defective sheet. Later, it was necessary to sort the pile manually to remove the defective sheets. While this method detected most sheets having major flaws, less noticeable defects required close manual inspection of each individual sheet.



Inspection, shearing, and sorting line is used to convert coiled tinplate and aluminum strips into cut sheets. Movement of material on the line is from the coiled strip unwind stand on the right to the three sheet pilers on the left. The line includes automatic gaging of strip thickness, visual inspection, and automatic pinhole detection. Sheets containing defects are automatically collected at a reject piler by means of a memory device.

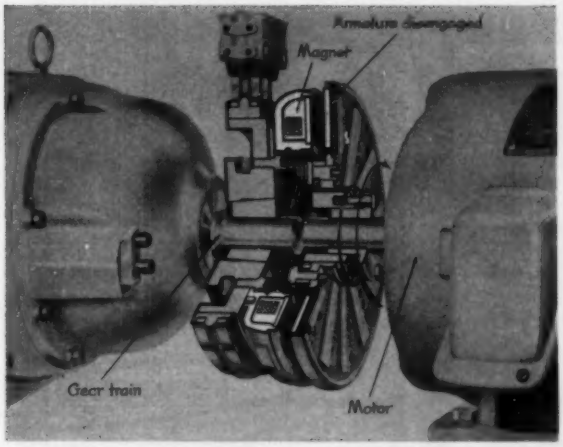
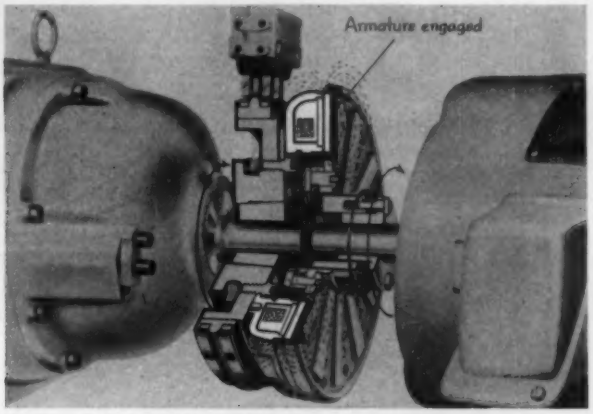


Fig. 1—Actuation of electric clutch and brake is based upon controlling magnetic force of an electromagnet faced with a friction material. Desired strength of coupling can be obtained as armature, also faced with friction material, is attracted to magnet.



CONTROLLING MOTION

WITH ELECTRIC CLUTCHES AND BRAKES

Complex machine operations can be resolved into basic motion functions that can be controlled simply, economically, and automatically by electric clutches and brakes. The author highlights principles of operation of these devices, showing by examples how they have been used to solve motion control problems.

By **JOSEPH F. PECH,** Chief Applications Engineer, Warner Electric Brake & Clutch Co., Beloit, Wis.

WHEN machinery makers and plant operators began intensified automation and mechanization of their machines and processes, they discovered that the mechanical power transmission devices traditionally used to control the rotary motion of shafts could not contend with greater machine complexity caused by increased speed, horsepower, and synchronization requirements.

Sophisticated devices are required to meet the needs of automation. Increasingly important among these devices are electromagnetic friction-disc clutches and brakes. Not only are such devices being used on modern machines, they are also being used to modernize existing equipment. They have proved to be reliable work horses in such applications as automatic clutching and braking, rotary indexing, positioning, rapid cycling and synchronization, torque and tension control, controlled acceleration, inching and jogging, and overload protection.

Device Characteristics

Belying their extremely broad range of application, two significant assets of friction-disc electric brakes and clutches are simplicity and compactness. Their capabilities range from 1/50 hp to 200 hp, which means that they can serve almost all automation loads. As for compactness, an electric stationary field clutch with a rated static (no-slip) torque of 1350 lb-ft can be obtained with an over-all running diameter of 15¼ inches and an axial dimension of

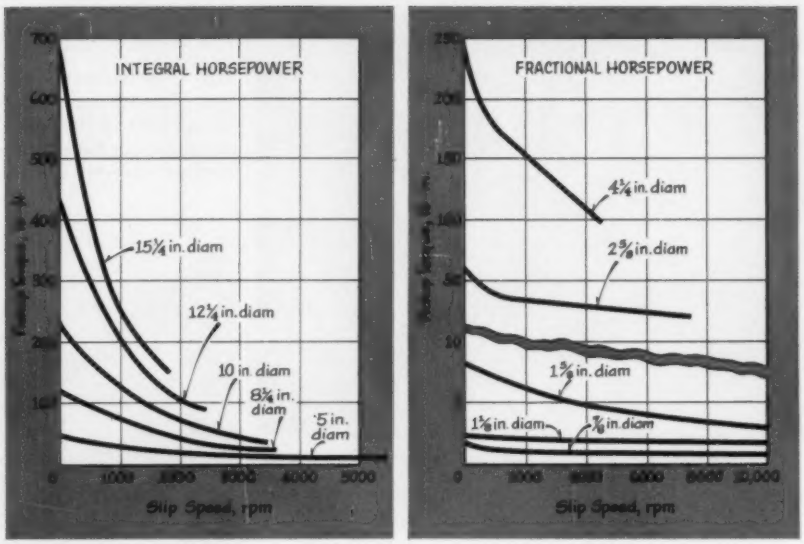


Fig. 2—Graphs relate nominal pick-up torque and slip speed for various sizes of clutches or brakes.

2-15/16 inches. A fractional horsepower clutch with a rated static torque of 8 lb-inches can be obtained with an over-all running diameter of $1\frac{5}{8}$ inches and an axial dimension of $1\frac{1}{8}$ inches.

Basically, an electric clutch or brake consists of an electromagnetic coil embedded in a doughnut-shaped steel casing faced with a molded friction material, *Fig.* 1. Its mating part is an armature disc constructed of segments brazed to a steel back plate that is fluted to produce a cooling action as it rotates. The armature is mounted on drive pins or a splined hub such that it can move freely back and forth axially.

Converted from regular 60 cycle ac current by a small control rectifier, direct current is sent through lead wires to the coil. This creates magnetic flux through pole faces and armature segments. The magnetic field pulls the armature forward on its drive pins or spline into direct contact with the friction surface of the field. The resulting friction of one face against the other creates the acceleration or deceleration torque to start or stop a load.

The amount of torque developed and its rate of buildup depend on the current level setting of the control rheostat or potentiometer. Thus, the performance of an electric brake can be varied from a con-

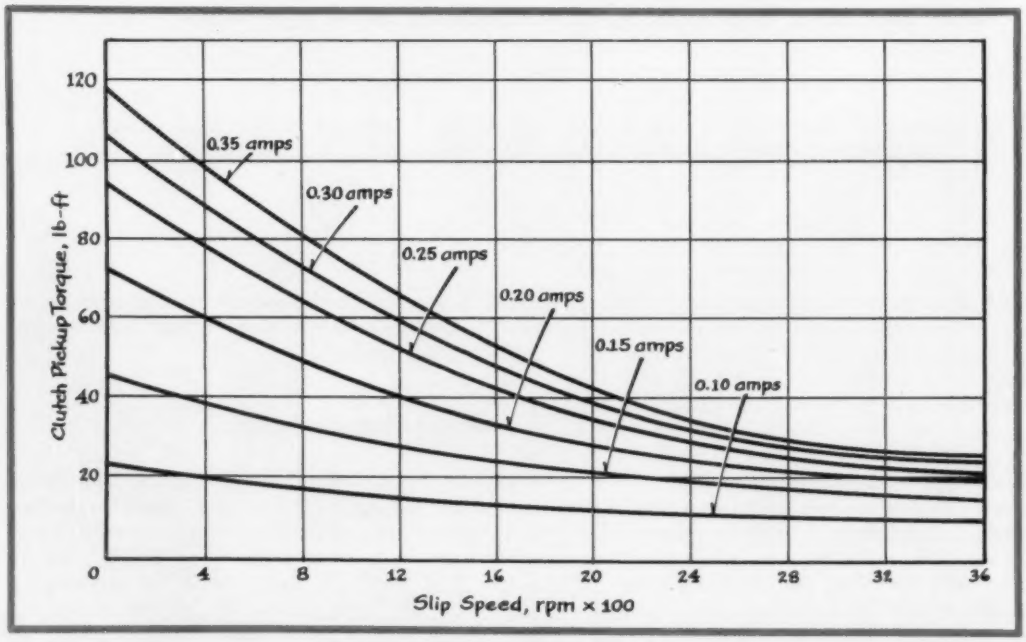


Fig. 3—Reflecting the degree of control available, this graph shows the pickup curves for various current settings for an 8¼-inch diameter clutch or brake.

stantly slipping (dragging) action to a positive, practically instantaneous stop. On a clutch, a high current level will produce a sudden engagement of the load while a lower setting will offer gradual or controlled acceleration, or constant slipping for tensioning or torque-limiting application. Torque can be adjusted steplessly.

Because power consumpton of electric clutches and brakes is minimal, control units are small, uncomplicated, and available off-the-shelf. The largest clutches and brakes operate on less than 40 watts. Current is applied to the units through slip rings and brushes or to a stationary field. In the latter case the magnet does not turn but instead causes an intermediate rotor to couple to the armature and rotates with it. In stationary field models, friction surfaces can be replaced without disturbing electrical connections. Both types provide automatic wear adjustment.

When the magnet is fixed to a stationary frame and the armature is mounted to the rotating driven shaft, the device is a brake. When mounted to rotating in-line driver and driven shafts, the device is a clutch coupling, engaging and disengaging the load from the driver. On power take-off applications, the unit is a clutch. Clutch and brake can also be combined for stop-start duty cycle drives.

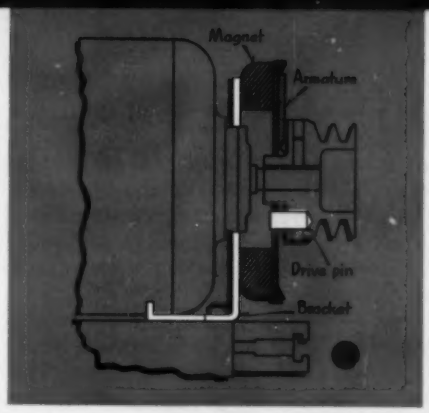
To the basic types of units should be added various packaged drive assemblies, recently developed, that permit clutches and brakes to be installed without special machining or complex alignment of many different parts. These are particularly well suited to modernizing existing equipment.

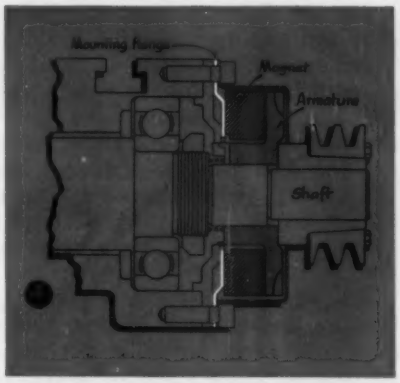
One such unit is an electric clutch integrally mounted with a ball-bearing pulley to form a packaged drive that slips directly onto standard NEMA motor shafts for drive modernization with no mechanical modification necessary. Another packaged unit combines a fractional-horsepower clutch and brake in a prealigned drive. Detachable outboard bearings maintain alignment despite severe side loading (from chains, gears, belts, etc.) and permit fast servicing in the field. These units can be bolted in place without any special mounting hardware.

Clutch and brake capacities are measured in pound-inches or pound-feet, and they range from 1.5 lb-in to 1350 lb-ft. The torque that can be developed by a unit is based on the size of its friction surface area and the flux density of the magnetic field as determined by the level of current supplied by the control. Pickup torque curves of a family of $\frac{7}{8}$ inch to $15\frac{1}{4}$ inch clutches and brakes can be seen in *Fig.* 2.

There may be a considerable performance overlap among the various sizes of clutches and brakes, but the normal torque rating for a unit is based on its zero slip or static torque at rated current—which is a brake's maximum torque with a stalled load and a clutch's maximum torque with the load locked in and running at full speed. The pickup curves for an $8\frac{1}{4}$-inch unit at various current settings are shown in *Fig.* 3.

Before 80 per cent of full torque is developed by a clutch or brake, magnetic flux must build up to 90 per cent of final value. But when the magnet is de-energized, torque available to the load plummets to 1 per cent while magnetic flux is decaying to 10 per cent of full value. In this way, the characteristics of electromagnetism provide swift but smooth engagement and instantaneous release. Special overexcitation controls can be employed to accelerate initial magnetic flux buildup by supplying higher-than-rated voltages for short periods.





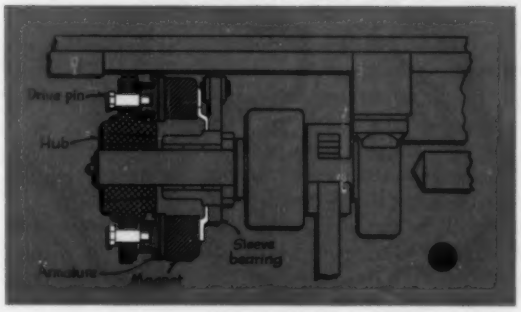


Fig. 4—Three types of mountings for brakes are shown. Typically, the magnet is fixed to a stationary frame, and the armature is mounted on the rotating shaft. In (a) the magnet is mounted on a foot bracket, in (b) to a stationary casting, and in (c) on a shaft bearing housing.

▶ Versatile Mountings

Depending on current setting, electric brakes can serve to stop a load instantly, decelerate gradually, or slip constantly. The progressive buildup of the magnetic field from zero minimizes or eliminates back-

lash or windup to make braking (and clutching) smooth and shockless.

Brakes can be mounted on shaft ends or through shafts. Usually, a brake is fixed to the shaft with the highest rotating speed to minimize the effects of machine inertia (allowing a minimum size brake to be used). Several different braking arrangements are illustrated in *Fig.* 4.

For a boring machine application, *Fig.* 4a, the brake is mounted on a foot-bracket bolted to a headstock frame member which supports the motor. The armature floats on three drive pins mounted to the inside flange of a V-belt pulley which is keyed to the motor shaft. Brake torque brings the spindle to a dead stop from speeds up to 3600 rpm.

For another application (a high speed moulder) power is delivered from the motor through pulleys and belts to a jackshaft. The brake armature is mounted by splined connection to the jackshaft, *Fig.* 4b. The shaft passes through the magnet section which is flange mounted to a stationary casting. Pushbutton control of the brake stops the jackshaft, cutter, pulleys and motor in three seconds from 7200 rpm. Former time was five minutes.

Still another mounting example can be taken from an application in which two brakes are used on a hopper-feed packaging machine. The brakes are controlled by a photoelectric circuit. One brake indexes the feed roll while the other controls the main cycle shaft, providing fine increment jogging and quick pushbutton stopping. The feed-roll brake armature is drive-pin mounted to a hub on the shaft with the magnet on the stationary sleeve bearing housing through which the shaft revolves, *Fig.* 4c.

Electric clutches can similarly be mounted for shaft-to-shaft and power take-off service to engage and disengage the driven from the driver shaft. Depending on current setting, clutch actuation can range from gradual to swift. Since the clutch frees the driver shaft from the load, the motor operates continuously at full speed, with its rotating inertia always available to the load, preventing over-motoring and vastly increasing the number of starts possible in a given period.

Clutches can be mounted in pairs or in series to perform a variety of functions in automatic machinery. For example, one cylindrical grinder has three units in its transmission, operated individually to control rapid traverse, fast feed, and feed cycle, *Fig.* 5. As another example, a guillotine cutter has two clutches mounted back-to-back inside a drum with both armature drive-pins mounted to a fixed spider while the fields are hub mounted to the drive shaft, *Fig.* 5. This doubling up provides nearly twice the torque of one unit while maintaining a minimum drum diameter. In pulley-to-pulley drives, a clutch can be mounted to the jackshaft and a brake to the motor shaft, or vice versa.

The integral clutch-brake unit is a power transmission tool for the swiftest starting and stopping, especially valuable in cycling operations. Simply stated, the clutch section of the device will engage the load at the start of the cycle and disengage it on a signal from pushbutton or switch. At this point, the brake will be energized to stop the load—all of which can be accomplished in well under a second. In fact, the number of starts and stops per minute can go as high as several hundred with fractional horsepower units.

These general remarks on clutch and brake operation, types, and mountings set the stage for the observation that their applications are limited only by ingenuity. The remainder of this article includes selected examples that illustrate what ingenuity has accomplished in overcoming major problems of automating motion control. The discussions deal with the functions of control, overload protection, tensioning, cycling and indexing, quick reversing, handling high inertia loads, speed changing and sequencing, and precision braking.

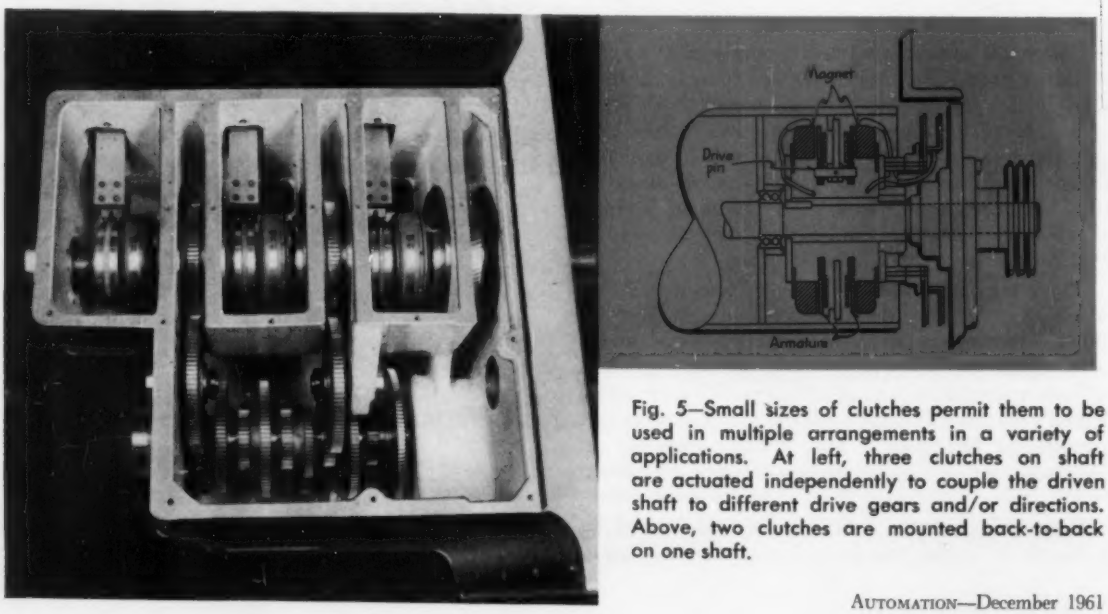


Fig. 5—Small sizes of clutches permit them to be used in multiple arrangements in a variety of applications. At left, three clutches on shaft are actuated independently to couple the driven shaft to different drive gears and/or directions. Above, two clutches are mounted back-to-back on one shaft.

CONTROL

Clutches and brakes can be activated with push-buttons and foot pedals, but automatic control can be simply achieved with electrical relays, limit switches, photoelectric cells, cams, timers, pressure switches, magnetic starters, current sensitive relays, thermostats, and practically any other component that can sense a change and send a signal.

In a conveyor installation, *Fig.* 6, boxes tumble from a horizontal power-driven conveyor onto an inclined gravity roller conveyor and past a photoelectric cell for detecting pile-ups. When the photocell beam is broken for a predetermined cycle as pre-set on a timer, an electric clutch is activated to disengage the load, stopping the conveyor and preventing further pile-up of boxes. When the boxes are removed from the photocell section of the conveyor, the light beam once more contacts the photocell, and the clutch is energized to start the conveyor.

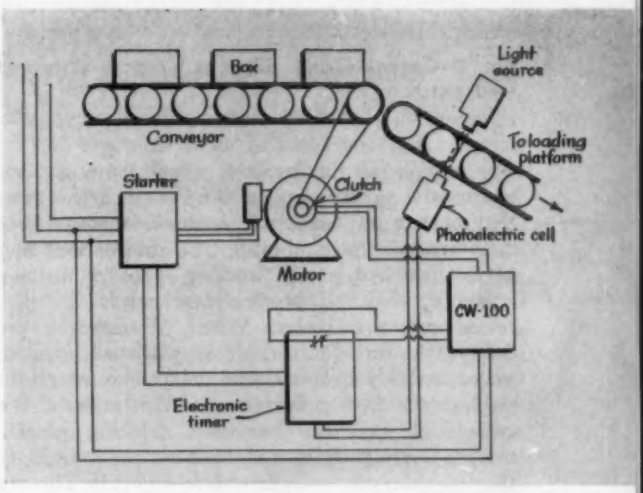
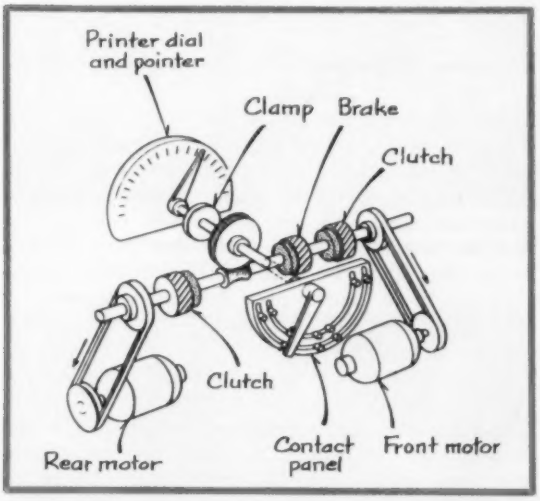
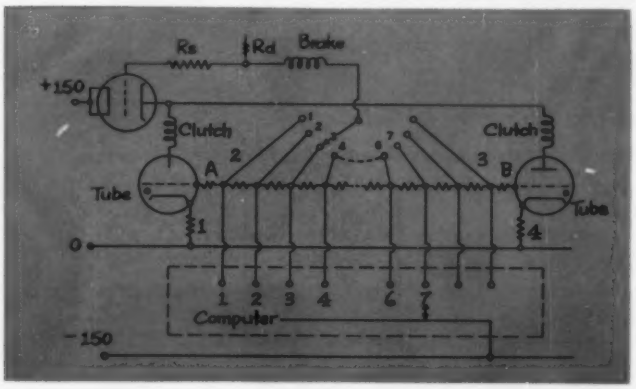


Fig. 6—Conveyor drive clutch is controlled by photoelectric means.





A more sophisticated example, a tape-controlled servo system of an automatic film printer, relies on a difference in exposure values to energize two electric clutches and an electric brake. The robot film printer drastically reduces motion picture film processing time while eliminating human judgment from the determination of light exposure.

A servodrive controls light values automatically, depending on the degree of negative exposure. The drive has two 1725-rpm motors, two fractional-hp clutches, one brake, worm gearing, and a shaft that sets a dial pointer, *Fig.* 7.

After comparing exposure values with settings punched into a tape, a computer calls for energizing one or the other of the pointer clutches. Any difference between tape and exposure values biases the grid of a thyratron tube, causing it to send a 200-volt pulse to the proper clutch. Over-excitation controls are used to cut down the clutch pick-up time.

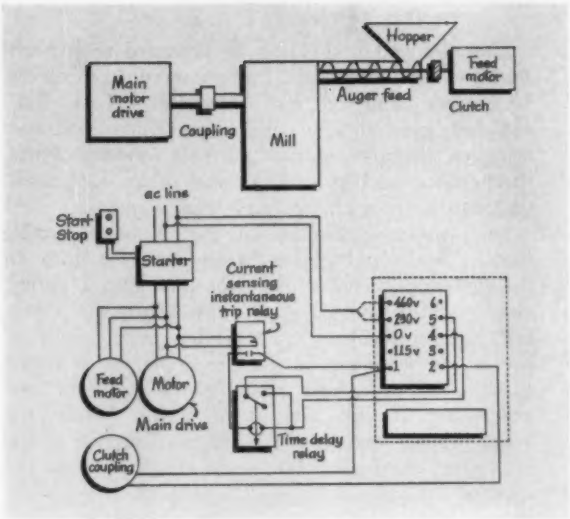
The activated clutch then drives the worm gear and the pointer shaft on the shutter control dial, until the contact-arm position neutralizes the grid bias of the thyratron tube. This de-energizes the clutch to disconnect the motor and activates the brake to stop the worm gear. When the next variation is detected, the adjusting cycle is repeated.

Fig. 7—In a servo system a shaft is driven in proper direction to neutralize grid bias of controlling thyratron tube.

OVERLOAD PROTECTION

Processing machines with automatic feed will benefit from clutch protection against overloads. Two methods are used. One is to set the clutch control current for the clutch to slip whenever the load torque demands exceed a certain value. The other is to use load-sensing devices to actuate the clutch.

Fig. 8—Current-sensing switch is used to disengage feed clutch.



An example of the latter is a mill with a 50-hp main drive motor and a 5-hp feed drive motor that powers an auger which draws material from an overhead hopper, *Fig.* 8. The rate of feed must be synchronized to the working speed of the mill.

Should the mill become overloaded, the main motor curent increases. When it reaches a predetermined level, a current sensitive relay in the motor circuit activates a time delay relay which disengages the feed motor clutch. With material flow cut off, the mill can clear itself, reducing the main motor's current draw and opening the contacts of the two relays to energize the feed clutch. The time delay relay operates only when current draw continues for a preset period and does not respond when motor surges are momentary.

TENSIONING

Faster processing machines that wind and reel have caused tensioning difficulties in many industries. Without constant tension control of material, these units could not have achieved their present production rates and quality. While some tensioning applications require the precision of a variable-speed drive, tensioning can often be done quite satisfactorily and at a much lower cost with electric clutches and/or brakes (see "Controlling Unwind Reels," page 78-80, AUTOMATION, Oct. 1961).

In processing conveyor belting on a 25-ft platen press, one plant had to maintain constant tension of 72-inch wide reeled material. To do the job, it installed an electric clutch on the input shaft of a four-speed transmission operating the wind-up reel, *Fig.* 9. In this jackshaft application, the clutch was linked to the motor shaft by pulleys and belts. Torque was set so that the clutch slipped continuously, gently maintaining proper tension on the roll.

During the operation, clutch torque is adjusted to compensate for the size of the roll. The operator first sets the transmission in its first gear. Shifting to the next speed, he boosts clutch torque to reduce slippage. In its fourth gear, the reel is rotating at its highest speed, and the clutch, though still slipping, is at its highest torque.

To serve as a drag, a constantly slipping electric brake was installed on the let-off reel of the press to prevent pile-ups of processed belting. When the belting sags low enough to contact a limit switch, the brake grips harder for an instant to take up the slack.

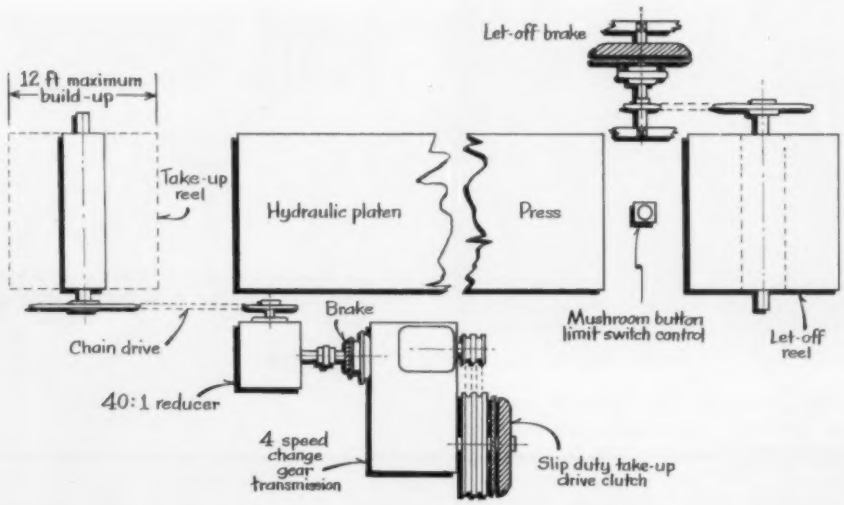


Fig. 9—Continuous conveyor belting is indexed through a platen press.

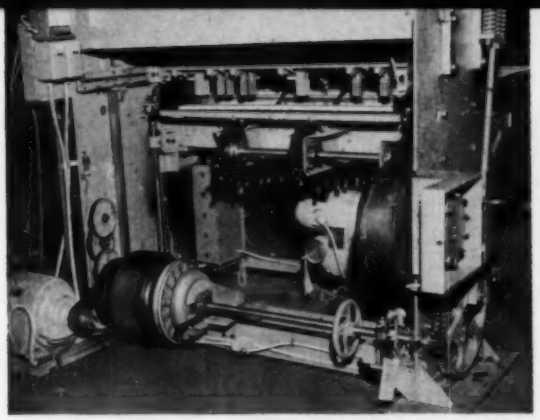


Fig. 10—Clutch-brake combination provides single-cycle control of nail machine main drive.

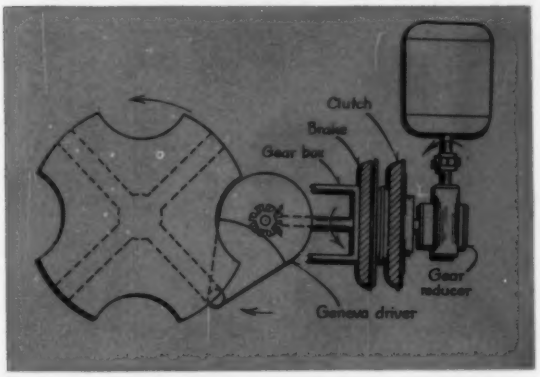


Fig. 11—Continuously running motor indexes table by clutch-brake arrangement.

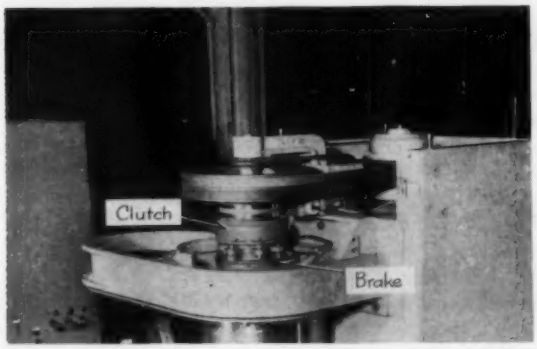
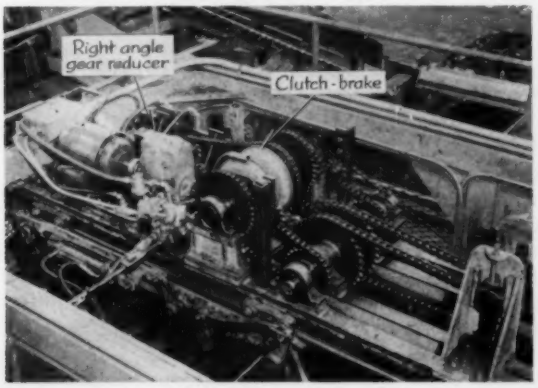


Fig. 12—Auger of filling machine cycles up to 70 times per minute.

Fig. 13—Sequential automatic welding of automotive parts employs clutch-brake combination.



CYCLING AND INDEXING

A simple example of the solution to a cycling problem is a clutch-brake arrangement that controls the single revolution cycle of a nailing machine's main drive, *Fig.* 10. The brake armature is connected to the drive shaft through the mounting hub of the clutch armature while the magnet is fixed to a bracket bolted to a base. The clutch magnet and collector ring assembly are mounted to a motor-driven flywheel. A foot pedal starts the nailing cycle by clutching in the load. On completion of a stroke, a limit switch is actuated to de-energize the clutch and energize the brake.

Going one step further into complexity is the drive for a Geneva wheel indexing table, *Fig.* 11. Here, a clutch-brake is mounted between a right angle gear reducer and the gear box. Indexing is precisely controlled by the clutch-brake's start-stop action. If a part is incorrectly fixtured in the table, a limit switch cuts off the clutch and sets the brake to stop the drive and prevent jamming.

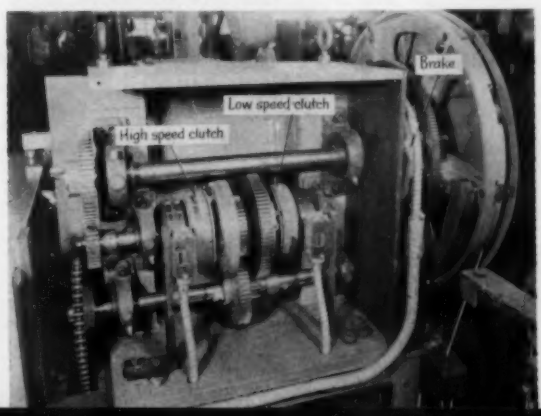
A fill-packaging machine that cycles up to 70 times per minute has a clutch and a brake installed atop its vertical auger, *Fig.* 12. To start the filling cycle, the clutch engages the auger to the drive. A limit switch is actuated when exact weight of fill has been reached (within plus or minus 2 per cent), disengaging the load and braking it.

In an automotive plant, front floor pans are welded in a T-shaped machine which has parts feeder lines entering from both ends of the T top. The parts are welded to the floor pan in sequential, automatic operations made possible by automated shuttles, elevators, and transporters that are powered by right angle drives, *Fig.* 13, controlled by clutch-brakes energized and de-energized by limit switches.

Three electric brakes and two clutches cycle and position in a machine that automatically measures, cuts, marks, and strips the ends of wire segments. One operational step consists of marking the wire at narrow intervals near both ends and at wider spacings for the remainder of the run. To accomplish this, two feed clutches, *Fig.* 14, engage the fast and slow gear trains, as signalled.

End stampings are produced as the wire moves at 6 inches per second, with intermediate markings

Fig. 14—Two clutches provide different indexing of wire length in marking operation.



made at 30 inches per second. Position accuracy is controlled by an electric brake which stops the feed roll after each segment is indexed to desired length plus or minus 1/16 inch. A separate clutch-brake operates the transmission which controls the actual wire cutting and trimming.

QUICK REVERSING

Quick reversing is another motion control function of machinery which can be readily accomplished with combinations of clutches and brakes. Often, only a pair of clutches is needed.

For ordinary reversing service, a forward clutch can be disengaged from a pulley, and a second clutch can be actuated to drive in reverse. If ultra-fast reversing is needed, the second clutch can be energized before the first clutch releases. Beginning to drive in the opposite direction while the first clutch is still relinquishing its grip on the load, the second clutch first acts as a brake before clutching the load in the opposite direction.

In a lead screw tapping machine, fractional horsepower forward and reverse clutches, operating without overlap, have eliminated the need for a reversing motor and complex gearing while heightening machine speed, *Fig.* 15. The armature of the downfeed clutch is keyed to the continuously rotating motor shaft, its rotor is mounted on the lead screw, and its stationary field is fastened to an internal bracket. The armature of the reversing clutch is bearing-mounted on a sheave driven by a V-belt from a reversing idler pulley.

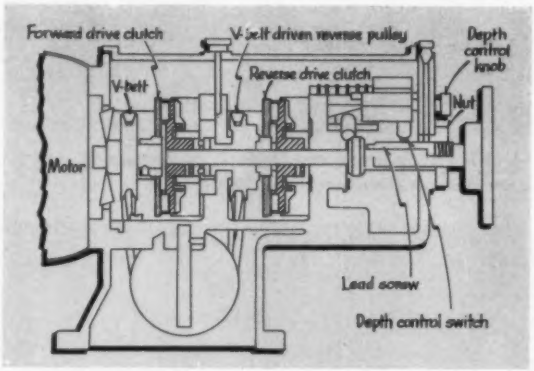


Fig. 15—Two clutches eliminate need for a reversing motor.

Energizing the downfeed clutch drives the lead screw down to tap the workpiece. At preset depth, a nut pushes a snap-acting switch to deactivate the downfeed clutch and energize the reversing clutch, withdrawing the tap from the work. Another switch is hit at the top of the stroke to de-energize the reverse clutch, thus completing the cycle.

Mounted back-to-back within and on opposite sides of the main drive pulley, two clutches perform a spindle reversing operation in a high production turret lathe, *Fig.* 16. Compact size of clutches permitted their mounting inside the pulley, which rotates on the drive shaft. Rotor of the forward clutch was keyed to the drive shaft and through gearing to the machine spindle. The reversing clutch was keyed to a free running sleeve around the drive shaft with a sprocket to reverse the spindle.

When the forward clutch is de-energized, the reverse clutch is simultaneously energized to act as a brake before picking up the load. Reversing, inching, and jogging are lightning fast with such an arrangement. It was not necessary to overmotor to get the instant response required.

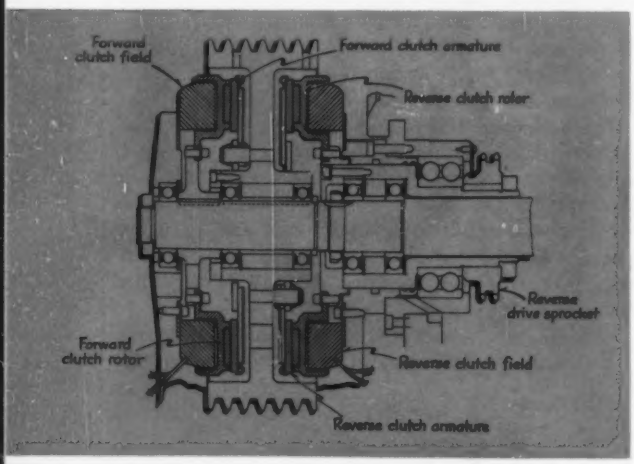


Fig. 16—Two clutches are mounted inside pulley.

HIGH INERTIA LOADS

Electric clutches are being used to provide controlled acceleration and overload protection where loads have high inertia or where high static friction loads require a great deal of torque to break them free.

To start a high inertia load, some plants have applied motors with excessive horsepower or motors with special windings that develop high starting torques. On starting, a standard torque motor will draw up to six times its normal running current while developing about 150 per cent of normal operating torque. During acceleration of the motor, the torque curve builds up to a peak of from 250 to 300 per cent of normal running torque before dropping abruptly (torque characteristics will differ from motor to motor).

A high inertia load may prolong a motor's acceleration period, overheating and perhaps damaging it. With an electric clutch, however, the motor can be allowed to start with no load and accelerate normally to its torque peak before gradual clutching action is applied to pick up the load without a jolt or strain to the motor. Many times a smaller motor can be used.

SPEED CHANGING AND SEQUENCING

Co-ordination of multiple machine members is a motion control problem that is being compounded by the increasing degree of automation and precision of modern machines. More operations are being performed, vastly complicating machine cycles and requiring millisecond response from brakes and cutches.

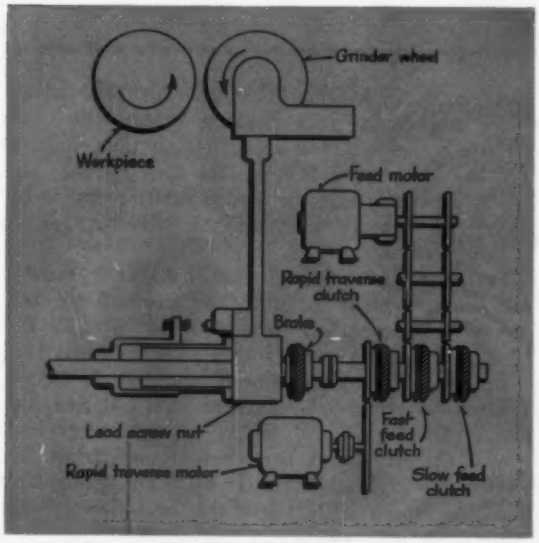


Fig. 17—Three-part feed cycle (rapid traverse, fast, and slow feed) is provided by three clutches.

For instance, an electrically controlled annular form grinder, *Fig.* 17, must automatically plunge grind cylindrical parts of irregular form OD to an exact finished size. Compared to some of the special purpose tools, the grinder is a general purpose machine of relative simplicity. But this does not imply that its fewer working members require any less precision or co-ordination.

After the workpiece is located and clamped in a motor driven fixture of the grinder, a pushbutton begins the feed cycle, which includes rapid traverse, fast feed, slow feed, and rapid traverse return. When the pushbutton is pressed, a brake on the lead screw is de-energized and a clutch is simultaneously activated to couple in the lower motor for rapid traverse of the wheelhead. A limit switch disengages the rapid traverse clutch and engages a fast feed clutch which advances the wheelhead forward at a brisk pace.

At the end of fast feed, a second limit switch disengages the fast feed clutch and engages the slow feed clutch which moves the wheelhead forward at a slow rate until the workpiece is ground to size. When this happens, an automatic gage cuts out the slow feed clutch and engages the lead screw brake, halting the wheelhead feed. After a predetermined dwell period, the brake is released, and the rapid traverse clutch is engaged to retract the wheelhead to its starting position. Here, a limit switch disengages the clutch and engages the lead screw brake to stop the wheelhead.

In a more complex situation, a carpet maker equipped a carpet tufting machine with 240 electric clutches to vary loop height of yarn so that he could

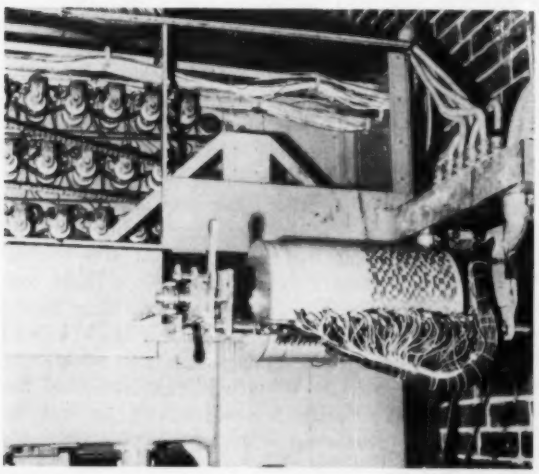


Fig. 18—Pattern on drum controls 240 clutches in a carpet tufting machine.

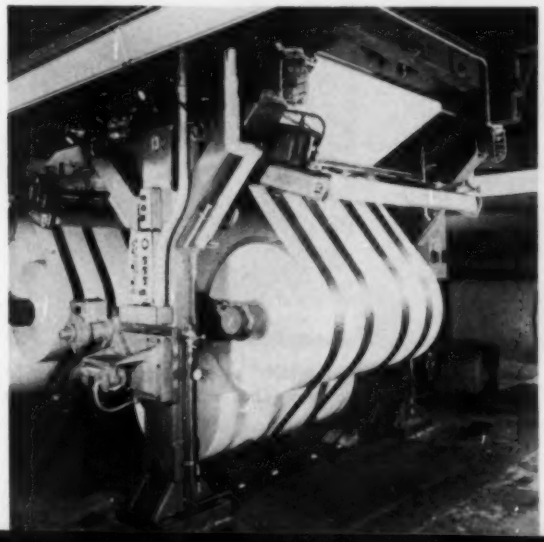


Fig. 19—Brake for each roll spindle steadies a roll for automatic paper splicing.

weave with a sculptured effect. Height of the loop is controlled by increases and decreases in the speeds of rollers which feed yarn to needles that poke yarn loops through a backing material.

Each roller has two clutches—one for high feed speeds of yarn (tall loops) and the other for slow speed (short loops). Signals activating the clutches are sensed by fingers and a rotating drum with the carpet pattern cut into its surface, *Fig.* 18. "Feeling" the drum surface, fingers trigger a relay in the control system to switch from one clutch to the other. Since the machine tufts up to 720 stitches per minute, cycling is a millisecond operation.

Synchronized electric brake actuation and release makes possible an automatic paper splicing operation that in turn allows continuous newspaper printing runs at speeds of up to 60,000 newspapers per hour. Mounted on one end of each paper roll spindle, *Fig.* 19, the electric brakes keep the often unbalanced paper rolls from rocking during the pasting operation. When the new roll is indexed into pasting position, a brush and web-severing carriage is lowered so that the flap of the incoming roll can be pasted to that of the expiring roll. Brakes are energized automatically to keep the spindles of the two rolls on an even keel and then released simultaneously. Compactness of brakes permitted their installation into enclosed spindle indexing assemblies.

PRECISION BRAKING

In conventional start and stop functions, clutches and brakes can be energized and de-energized without overlap. Although extremely rapid indexing and positioning is possible with this method, much swifter action can be attained by activating a brake before a clutch releases. Building flux during the waning part of clutch disengagement, the brake can develop sufficient torque to halt the load immediately after the clutch lets go. As speed and precision demands of modern machinery rise higher, this "conflicting torque" or make-before-break system will inevitably find growing application.

A brake that is able to stop a load with 90 per cent of its full torque may take almost 70 milliseconds to develop this level of magnetic flux. But when the brake is actuated before the clutch releases, it can stop the load in slightly more than 10 milliseconds, which amounts to a saving of nearly 60 milliseconds per action. Multiplied by many stops per second or minute, the saving in braking time can result in a remarkable gain in productivity. More important, since braking repeatability with electric brakes is within approximately plus or minus 1/5 the total travel between the time the stop signal is generated and the load actually stops, shortening the stopping time interval increases over-all braking precision.

Premature actuation of brakes makes it possible for one tire plant to fulfill specifications for feed conveyors that called for speeds as high as 200 rpm, a cutting accuracy within plus or minus 1/32 inch, and total braking time of less than ½ second. Desired performance is obtained with but two electric clutches and one brake. Advancing at high speed, the tire tread trips a limit switch to disengage the high speed clutch while energizing both the slow speed clutch and the brake to provide twice the braking torque of a single unit.

As the slow clutch locks in, the tire tread activates a second switch that is ½ inch away from the first, de-energizing the slow speed clutch. Still operating, the fully energized brake then halts the load within ⅛ to 3/16 inch beyond the second switch.

In another operation using the same principle, the feed drive of a high speed metalworking press stops lithographed strip steel to within plus or minus 1/32 inch at the rate of 120 times per minute. Cycling 120 times per minute, a crank powers the main drive of the press. For each cycle, a cam switch on the press ram activates a clutch to engage the feed rolls to the crank. At the end of half a cycle, the cam switch energizes a brake and a photocell sensor, *Fig.* 20. As the steel strip moves into the press, the photocell detects a black register mark on the strip and sends a signal to release the clutch so the already energized brake can stop the feed drive, practically instantaneously to stay in register. Now, the strip is accurately positioned for the forming half of the cycle.

Before automation, mechanical clutching (with periodic adjustment for cumulative positioning errors) held the production rate to 20 to 25 pieces per hour. Photocell sensing and electric clutches and brakes have obviated cumulative errors and have increased productivity nearly sixfold.

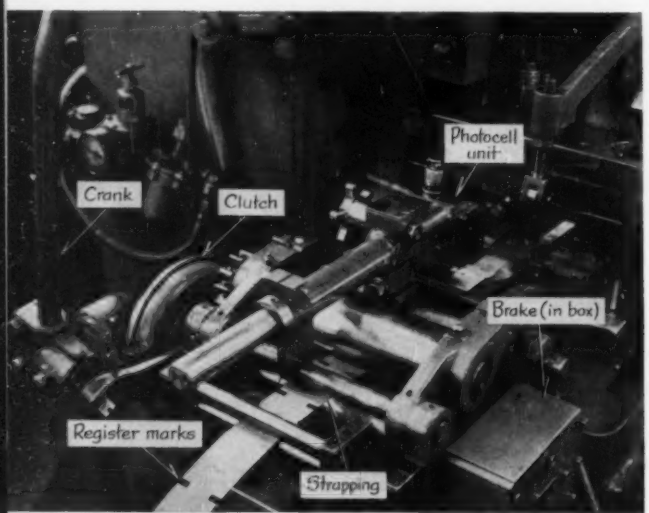


Fig. 20—Photoelectric system senses register marks to disengage clutch, allowing cam actuated brake to stop feed.

HYDRAULIC CIRCUITS TO AVOID OVERHEATING

By **WARREN BROWN,** Vickers Inc., Detroit, Mich.

MAINTAINING proper fluid temperatures to avoid overheating is an important consideration in the operation of industrial hydraulic systems. This fact is generally recognized by industry and finds concrete expression in hydraulic standards such as those of the Joint Industry Conference. The concensus appears to be that industrial hydraulic systems using petroleum base fluids perform best if maximum pump inlet fluid temperatures can be held to 130 F or lower. Where water base fire-resistant fluids are used, maximum fluid temperatures may be limited to 120 F.

An effective way of limiting heat build-up in hydraulic fluids is to recognize sources of unwanted heating and to eliminate or minimize them in the circuit design stage. For example, where circuits introduce resistance to fluid flow, pressure drop or loss of energy results and shows up in the form of heat added to the system. The rate of heat generation is given approximately by the formula:

$$H = 1.49FP$$

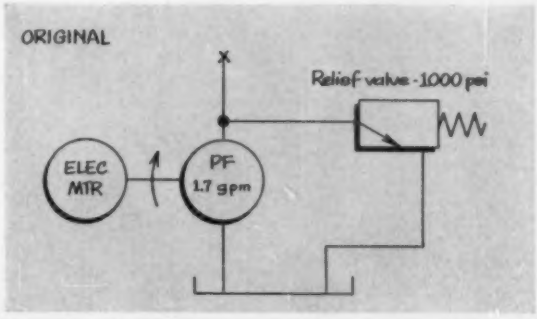
where H is the rate of heat generation in Btu per hour, F is the fluid flow rate in gpm, and P is the pressure drop in psi. Obviously, anything that can be done to decrease pressure drop caused by flow resistance, or to shorten the time that such pressure drop is applied, will reduce the amount of heat generated per operating cycle or period.

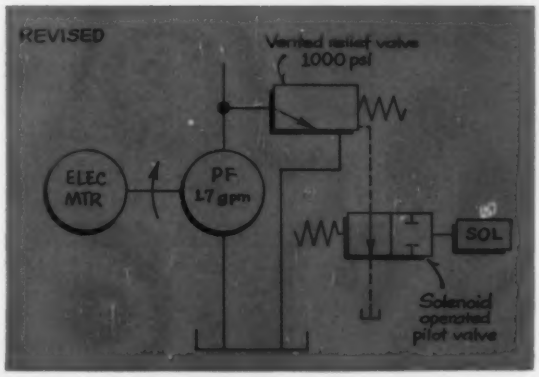
The examples to follow illustrate common circuit designs that can lead to unnecessary fluid heating. Accompanying each "original" circuit diagram is a suggested "revised" circuit diagram designed to perform the same function but generate less heat. A description of the heating problem and a solution are given for each example.

It is understood, of course, that when the circuit designer has done all possible to eliminate the causes of heat, and still knows that heat will be added to the system faster than it will be rejected, then forced cooling may be required. Both air and water cooled heat exchangers are available for the purpose. The choice between them is influenced by factors such as cooling capacity, cost, space, weight, and availability of cooling medium.

Based on discussion material presented at the "Fourth Fabricating Machinery Hydraulic Conference" sponsored by Vickers Inc., May 1961.

Pump Unloading

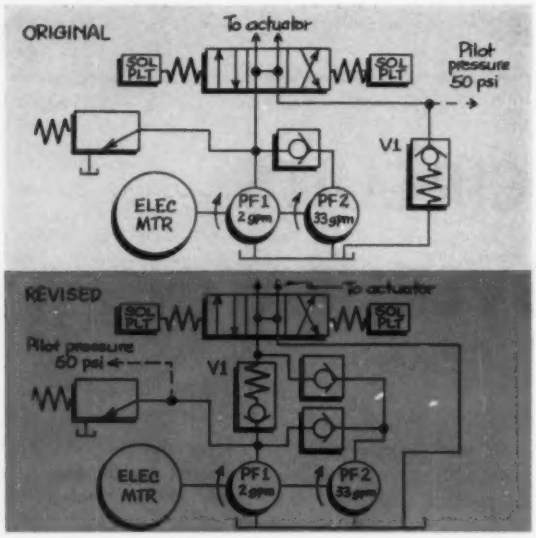




The original circuit will generate about 2530 Btu per hour of heat when the entire flow of 1.7 gpm from the pump passes through the relief valve at 1000 psi.

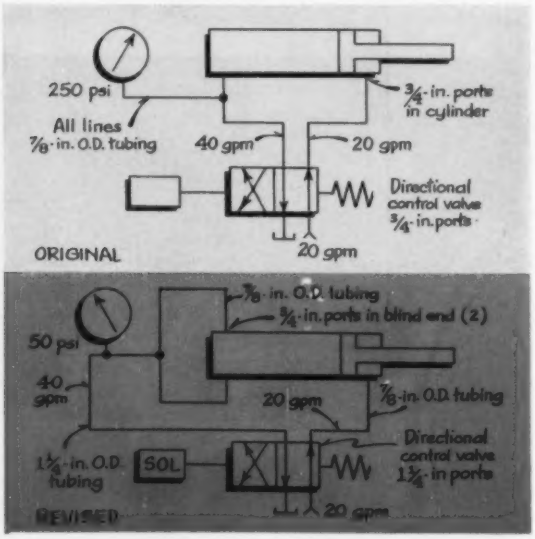
If heating with this system is a problem, the revised circuit may be substituted in which a vented relief valve is used with control effected by a solenoid operated pilot valve. With this arrangement, the pump pressure may be reduced to 30 psi by de-energization of the solenoid when full pressure is not required. At such times, heat savings of approximately 97 per cent, or 2450 Btu per hour, may be realized.

Obtaining Pilot Pressure



In the original diagram for a double pump circuit, special check valve *V1* in the fluid return line is adjusted to develop 50 psi back pressure for application to pilot circuits. With the outputs of both pumps exhausting to tank, 35 gpm of fluid will pass through *V1* and develop approximately 2610 Btu per hour of heat. In the revised circuit, 50 psi of pilot pressure is developed across *V1* with only 2 gpm of fluid from the small pump. Fluid from the large pump flows freely to tank through a conventional check valve. Heat savings of about 94 per cent, or 2460 Btu per hour, can thus be obtained with the revised circuit.

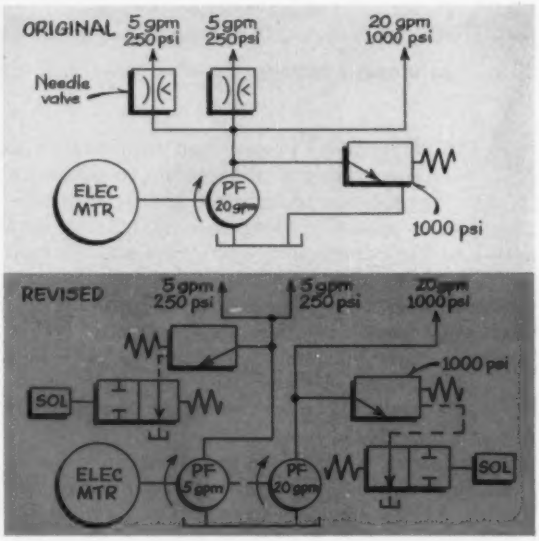
Sizing of Components



When 20 gpm of fluid is fed to the rod end of the cylinder in each of the circuits shown, 40 gpm of fluid will be swept from the blind end because of the 1 to 2 area relationship on opposite sides of the piston. With the piping and cylinder shown in the original circuit, a pressure as high as 250 psi can be developed at the blind end with the rod retracting at no load. Thus, if each return stroke lasts 5 seconds and occurs three times per minute, approximately 20.6 Btu per return stroke, or 3710 Btu per operating hour, will be released because of flow resistance in this portion of the circuit.

By specifying a cylinder with two blind end ports and by adopting the pipe sizes and arrangement shown in the revised circuit diagram, blind end pressure can be reduced to 50 psi when the rod retracts with no load. This will save approximately 80 per cent in heat generation during the return stroke. A cylinder with a single, 1¼-inch port in its blind end could be substituted for the cylinder shown in the revised circuit and would provide similar heat savings.

Supplying Auxiliary Circuits

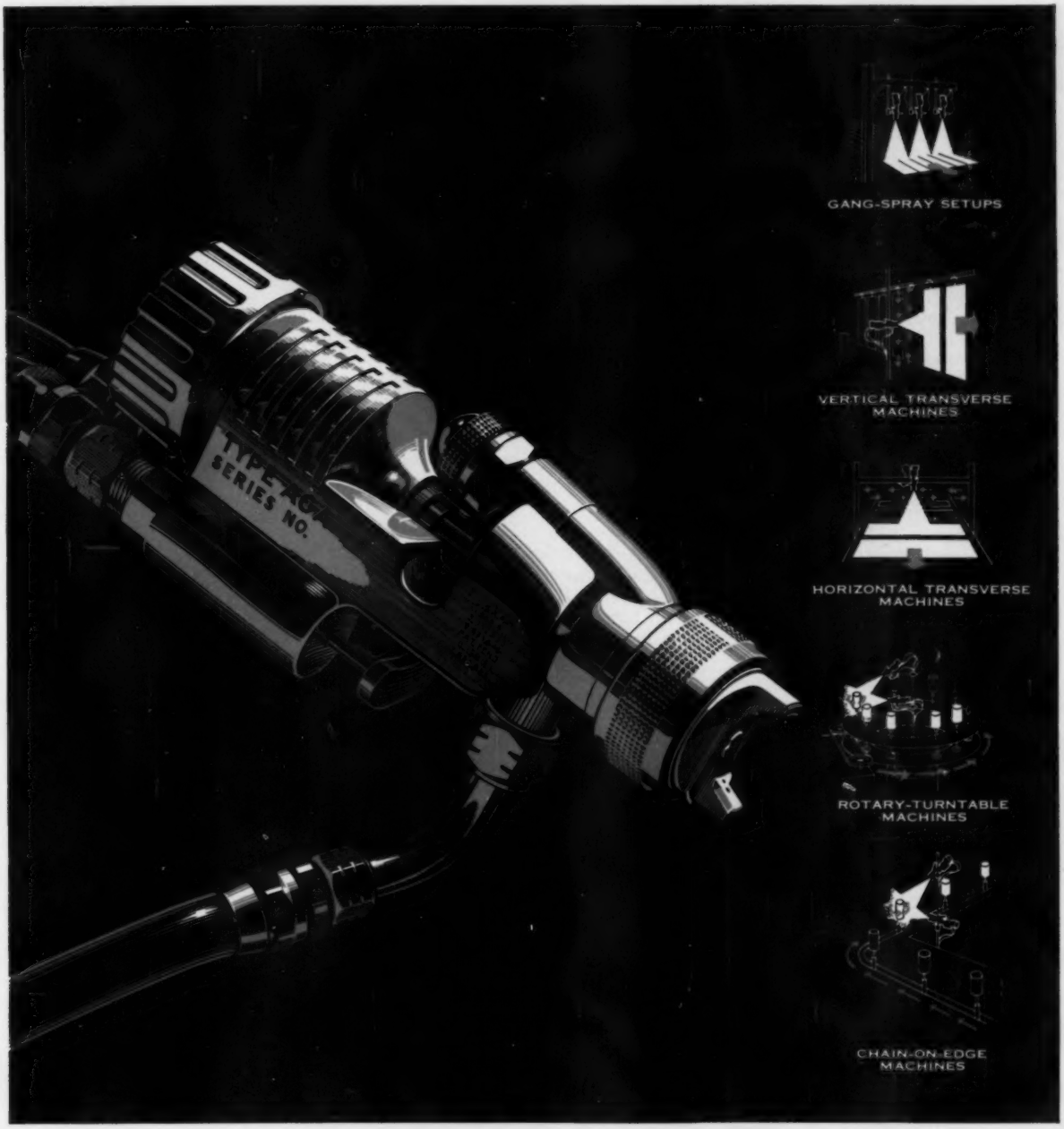


In a multiactuator system, a large cylinder requires 20 gpm at 1000 psi and each of two auxiliary cylinders requires 5 gpm at 250 psi, all at different times. In the original circuit, a single 20 gpm pump is used to supply the actuators. Fluid for each auxiliary cylinder is obtained through a needle valve set to provide a pressure drop of 750 psi at 5 gpm.

As each auxiliary cylinder is operated, its needle valve can add heat to the system at the rate of about 5590 Btu per hour. If auxiliary cylinder actuation occurs only three times per minute on a 2 second cycle, about 560 Btu will be added per system operating hour by each auxiliary cylinder circuit. More importantly, however, the excess 15 gpm from the pump will pass through the relief valve at 1000 psi and generate heat at the rate of 22,400 Btu per hour during the period that either auxiliary cylinder is operated.

If the cycle includes periods when the large cylinder as well as the auxiliary cylinders do not require fluid, then all of the output of the 20 gpm pump will flow through the relief valve at 1000 psi in the original circuit. This will generate heat at the rate of 29,800 Btu per hour during such periods.

In the revised circuit, a separate 5 gpm pump is used with a vented relief valve set at 250 psi. During periods when the auxiliary cylinders are not being operated, the pump can be unloaded. Heat generation with this auxiliary cylinder circuit is only about 45 Btu per system operating hour. The 20 gpm pump may be similarly equipped with a vented relief valve arrangement so that this component can be unloaded when flow is not required.



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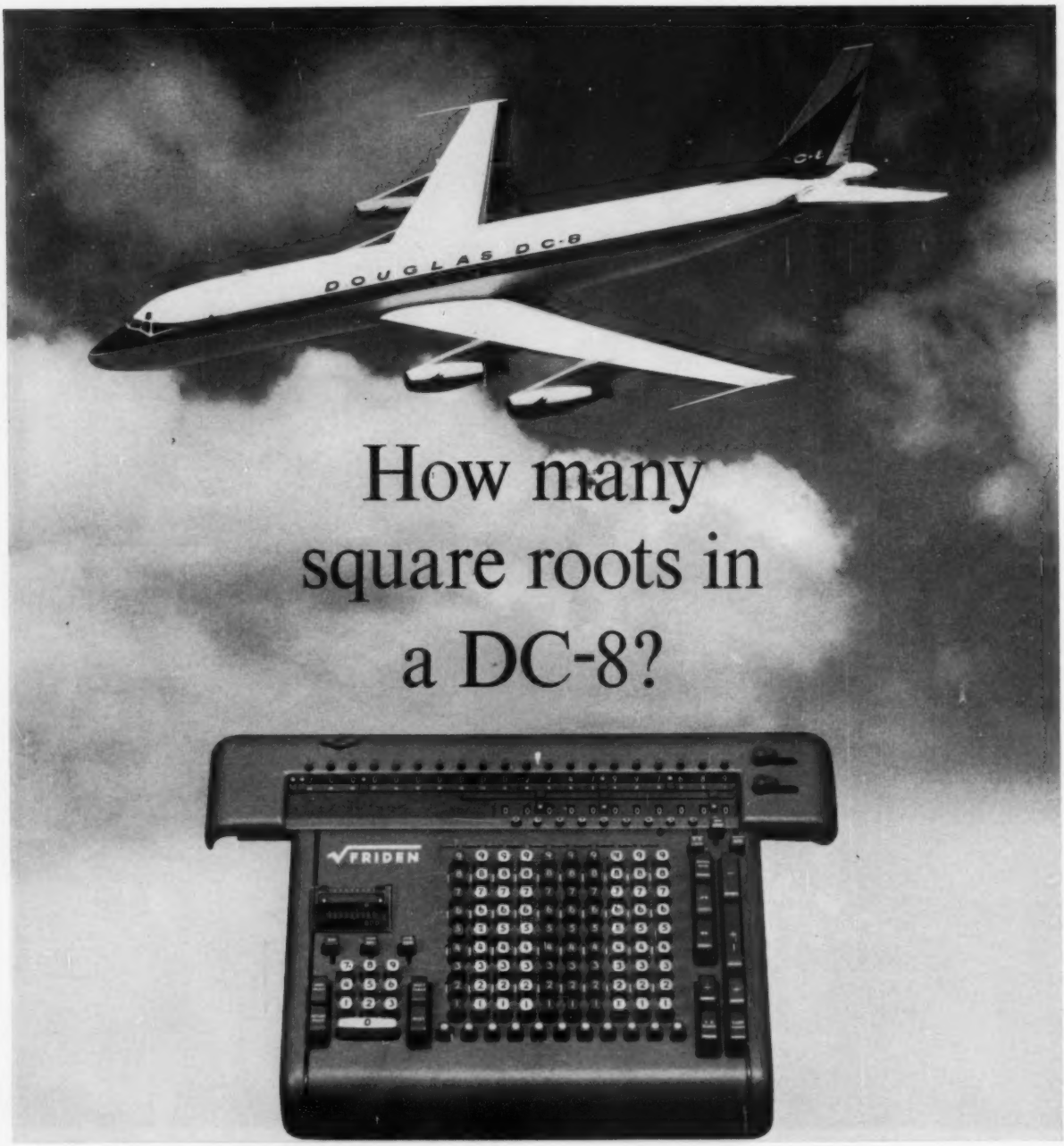

Thousands? *Tens* of thousands would be more like it. The point is this: if Douglas had used conventional methods of extracting those square roots, the DC-8 would probably have been longer getting off the ground. Ordinary square root methods are both a man-hour bottleneck and a constant source of errors.

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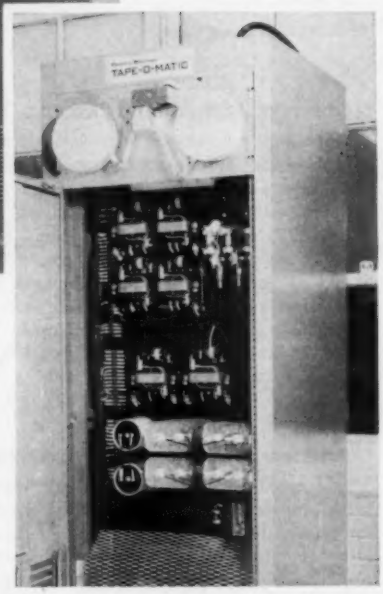
Single-spindle numerically controlled drill is ideal for use in many metalworking shops. Controls are not affected by temperature or line voltage fluctuations. Slides are continually monitored during drilling for correct position. This provides for much faster, more accurate table positioning, and no chance of damage because the table position cannot change during drilling. Tool change code on tape automatically stops machine cycling and advises operator, by means of light, to change cutting tool.

Numerically Controlled Single Spindle Drill

DEVELOPED by **Pratt & Whitney Co. Inc.**, Charter Oak Blvd., W. Hartford 1, Conn., this numerically controlled drilling machine has been specifically designed to be mass produced (price of basic machine is $8595). It is ideally suited for small or medium runs and for many one-piece runs. The Tape-O-Matic single-spindle drill eliminates jigs, replaces from 2 to 10 or more conventional drilling spindles, cuts lead time and floor to floor time, and eliminates positioning errors.

The controls and the machine itself form a closed loop servo system. Position of slides is commanded by information on standard, 1-inch wide punched tape. Positioning of both axes is done simultaneously. Logic circuitry is composed of transistorized, plug-in printed circuit boards arranged in a *Nor* configuration. Four different boards make up the vast majority of components. The printed circuit *Nor* cards are plugged into a "mother" board which has wire wrapped connections between circuits.



View of inside (front) of Tape-O-Matic numerical control cabinet. This compact control housing occupies little space and is easy to reach for routine maintenance. Tape reader is located at top of cabinet.

Dimensional information to the machine can be positive or negative since the machine has a "floating zero which allows it to operate in all four quadrants and enables the operator to set up and zero his workpiece anywhere within the travel limits of the table's working surface. Cylindrical ways and recirculating ball bearings are used to avoid static and dynamic friction. Backlash or lost motion at reversal points is eliminated by recirculating ball bearing feed screws and nuts—under preload.

Table working surface of the drill is 30 by 20 inches. Longitudinal table travel is 20 inches and transverse table travel 15 inches. The drill has two infinitely variable spindle speed ranges: 300 to 2000 rpm and 150 to 1000 rpm. With optional feature of power feed, the spindle feeds in inches per revolution of spindle are 0.004, 0.006, 0.009, and 0.012. Position locating accuracy is ± 0.0005 inch + (0.0001 inch) (distance moved). Repeatability is ± 0.0005 inch.

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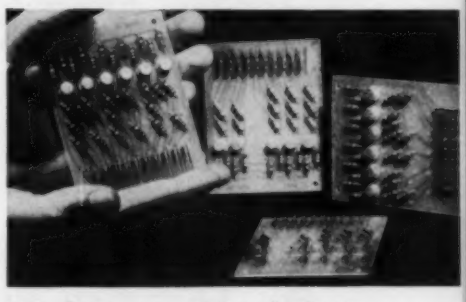

Drill features transistorized circuitry with modular construction. Four printed circuit boards make up vast majority of the machine's logic circuits. Spare part stocking is simplified since only one or two of each need be stocked.

PUNCHED CARD COLLATOR EQUIPPED WITH CORE MEMORY

Model 188 punched card collator has core storage in place of relays, and transistors instead of vacuum tubes. Basic functions of the collator include merging, matching, primary and secondary sequence checking, merging with selection, card selection, and editing (double punch and blank column detection). Three sequence modes of comparison are standard in the collator: Alphameric, numeric with blank equal zero, and numeric with blank detected as an error. These modes can be controlled by control panel wiring on a column-by-column basis. Card capacity of the main feed is 3600 cards, and the secondary feed hopper can hold 1200 cards. With both feeds in use, up to 1300 cards per minute can be processed. **Data Processing Div., International Business Machines Corp.,** 112 E. Post Rd., White Plains, N. Y.

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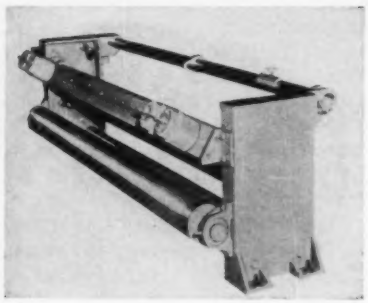

PNEUMATIC CONSTANT TENSION UNIT FOR WEB PROCESSING

Flexible in design, Model 900 constant tension unit can easily be adapted to existing printing, processing, and other converting equipment. Operation is based on plant air being supplied into the two connected air diaphragm cylinders mounted on top of the unit frame. These are connected through linkage to the sensing roll. The amount of air supplied to the cylinders sets the tension value in the sensing roll, accomplished through an air regulator located conveniently near the operator. On the end of the sensing roll pivot shaft is a cam, which actuates a plunger-operated air regulator, from which air is supplied to the brake. As the tension sensing roll moves down, there is less braking and vice versa, automatically controlling the web tension. **Stanford Engineering Co.,** Box 369, Salem, Ill.

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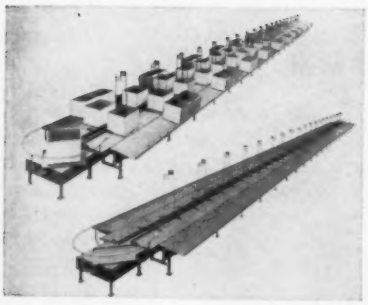

FLOOR TYPE, HORIZONTAL CAROUSEL CONVEYOR ASSEMBLED FROM MODULES

Specifically developed to provide a smooth, efficient flow of materials in production, assembly, and testing applications plus selective packaging and order packing, the Tota Tray carousel conveyor is assembled from standard modular components to provide custom installations from standard units at standard prices. Modular design permits the specification of height, length, and speed to meet exact requirements. The three basic interchangeable components consist of a drive-end unit, intermediate sections, and a take-up end assembly. This conveyor provides a continuous flow of closely nested load carrying pans to offer maximum work and conveying area in minimum floor space. Parts, components, and products of up to 30 lb per load pan can be conveyed at speeds up to 50 ft/minute. **Richards-Wilcox Mfg. Co.,** 800 Third St., Aurora, Ill.

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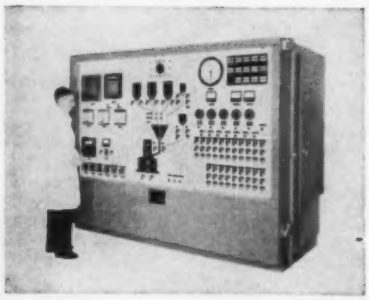
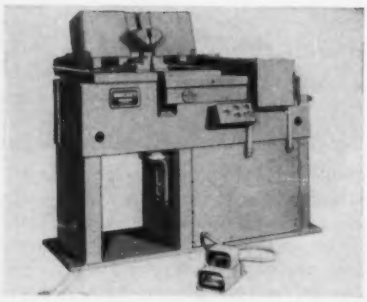


CONTROL PANEL FOR WEIGHING, MIXING, AND BATCHING OF BULK MATERIALS

Designed and built as a package unit, the illustrated control panel was developed for mixing and batching of polyvinyl chloride materials. Similar units may be designed for use in the food, chemical, drug, fertilizer, paint, rubber, and other fields, wherever large quantities of materials must be weighed, mixed and batched automatically at high speed. Controls are provided to adjust the setting for apportioning of each material, and to control the mixing time of the ingredients in a Banbury mixer. Feature of the system is a main scale whose lever system has no knife-edge pivots or other wearing parts. The panel incorporates automatic alarms for low bin levels, for batch weight variations, ventilator fan failure, and other eventualities required by a user. **Thayer Scale Corp.,** 1 Thayer Park, Pembroke, Mass.

Circle 405 on Reply Card



AIR OPERATED FLASH-BUTT WELDERS

Series BPR.O flash-butt welders are designed to cover a wide range of commercial welding applications. They will affect high quality welds on small or large production runs on a wide range of industrial metals. Four frame sizes are offered. Available in 20, 50, 100, and 150 kva at 50 per cent duty cycle, the welders can accommodate a maximum stock width of 6 inches, a maximum stock diameter of 3 inches, and a minimum diameter ring of 5 inches. Upset force up to 20,000 lb and clamp force of 30,000 lb is provided at 80 psi line pressure. Welders feature a roller bearing mounted moveable platen and micrometric vertical adjustment of the right hand platen to compensate for die wear or dies not machined in pairs. **Sciaky Bros. Inc.,** Dept. BPR.O, 4915 W. 67th St., Chicago 38, Ill.

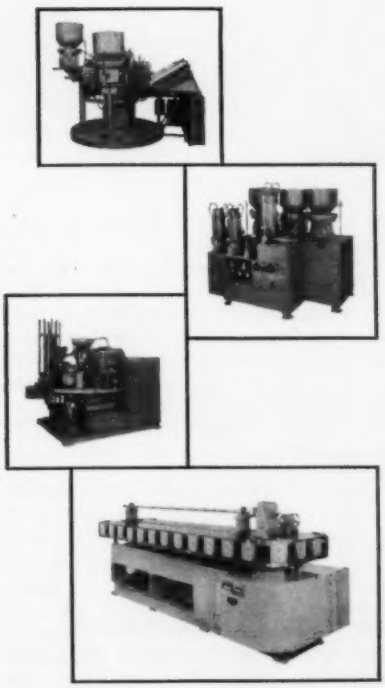
Circle 406 on Reply Card

For companies who use, or plan to use...

AUTOMATIC ASSEMBLY EQUIPMENT

Swanson-Erie Corporation offers a capable, imaginative and experienced source for automatic assembly and processing equipment. Over the past 20 years we have devoted our activities almost exclusively to the design and manufacture of highly efficient machines for the production of a host of consumer and industrial products.

We are in a position to best serve those companies who require top quality dependable complex equipment to produce in large volume with a high degree of mechanical reliability.



Swanson-Erie capabilities encompass a wide variety of products and services which include: *standardized indexing machine chassis in many types and sizes; the manufacture of special machines to customers' designs; an integrated service which encompasses the complete functional responsibility for special machine projects from design to final testing and development; the manufacture of proprietary machines for the high speed production of incandescent and fluorescent lamps, radio tubes, glass and electronic components.*

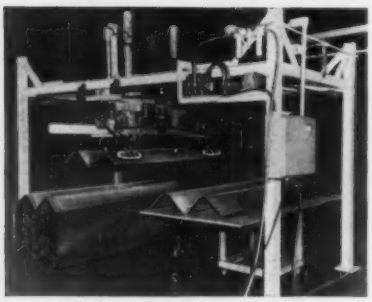
All are built to the most exacting standards of quality and reliability. All carry a guarantee of complete parts interchangeability. We welcome the opportunity to personally discuss special machine projects with firms seriously considering the use of automatic production equipment. And, we will be pleased to submit a proposal on those projects which fit within our scope of activity.

A booklet of our products and facilities is available on request.

SWANSON-ERIE CORPORATION

SEC 814 EAST EIGHTH STREET • ERIE, PENNSYLVANIA

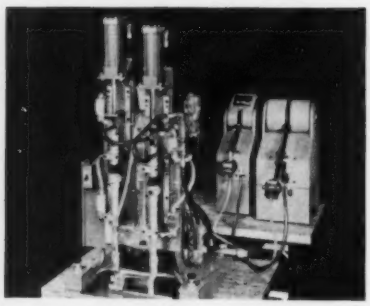
Creators of... Better Automatic Machines For Less Cost In Less Time



VACUUM FEEDER & DESTACKER SUITABLE FOR HANDLING VARIETY OF MATERIALS

Automatic transfer unit has been specially constructed to lift, transfer, and stack corrugated material up to 20 ft in length in less than 10 seconds. It can be adapted to handle flat stock as well. The transfer unit, featuring chain-sprocket and ball bearing carriage, is completely self-contained and is powered by a compact air motor and reducer, permitting cushioned starts and stops. The air motor is valved to act as a brake when the air supply is cut off. The lift mechanism is air cylinder and guide rod framework. Accurate positioning is maintained by a rubber-tired pad positioning device. **Vac-U-Lift Co., Div., Siegler Corp.,** Salem, Ill.

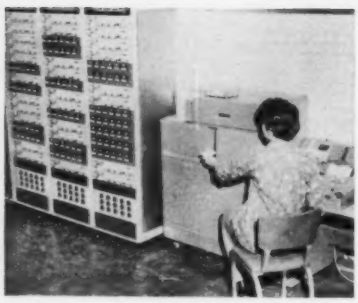
Circle 407 on Reply Card



STUD DRIVING MACHINE CUTS ASSEMBLY TIME IN HALF

Tru-Tork machine automatically feeds, orients, and drives different size self-tapping studs into a casting. This method of operation cuts the assembly time in half for an automotive parts supplier. Feature of the hopper-fed machine is that it drives from the thread. In operation, the operator places a part in a nesting fixture and actuates the palm buttons. The fixture clamps the part into position and starts the machine cycle. The driving heads come down, drive the studs, and return to their original position. When they return, they strike a limit switch which releases the clamping fixture, reloads the driving heads, and shuts off the air motors. Approximate cycle time is 2 seconds. **Clyde Engineering & Mfg. Co.,** 937 E. Ten-Mile Rd., Madison Heights, Mich.

Circle 408 on Reply Card



DATA SYSTEM IMPROVES SHOP OPERATION

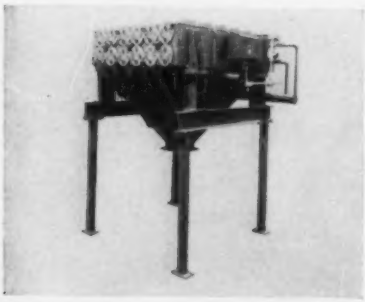
Readout-Telecontrol system gathers, organizes, and processes production data from every machine in a factory at a speed 180 times faster than was previously possible. At random times or through programming on a predetermined schedule, all information on the system's control panels is collected and recorded on punched cards at the rate of 100 cards a minute. In addition, the equipment enters the machine operator's clock number, shift, the part number, operation number, piece rate, order number, and other data on the punched cards. The cards are then fed into the plant's data processing equipment to yield payrolls based on piece work, production progress reports, machine utilization reports, and other control data. **Hancock Telecontrol Corp.,** 320 Park Ave., New York City, N. Y.

Circle 409 on Reply Card

SEALING MACHINE FOR MAKING GLASS TO METAL SEALS

Machine, designated Model 1243, has two positions for making high frequency seals. Parts to be sealed together by illustrated unit are three metal pieces with two glass pieces between. All of these seals are made simultaneously in one operation. The sealing operation itself takes about 8 seconds and is regulated by a precision timer control unit. The two positions may be used alternately and may be for different assemblies. Spacing of all parts is precise within a few thousandths of an inch. All coils are water cooled. Energy for sealing is supplied by a suitable H.F. power supply. **Kahle Engineering Co.,** 3322 Hudson Ave., Union City, N. J.

Circle 410 on Reply Card



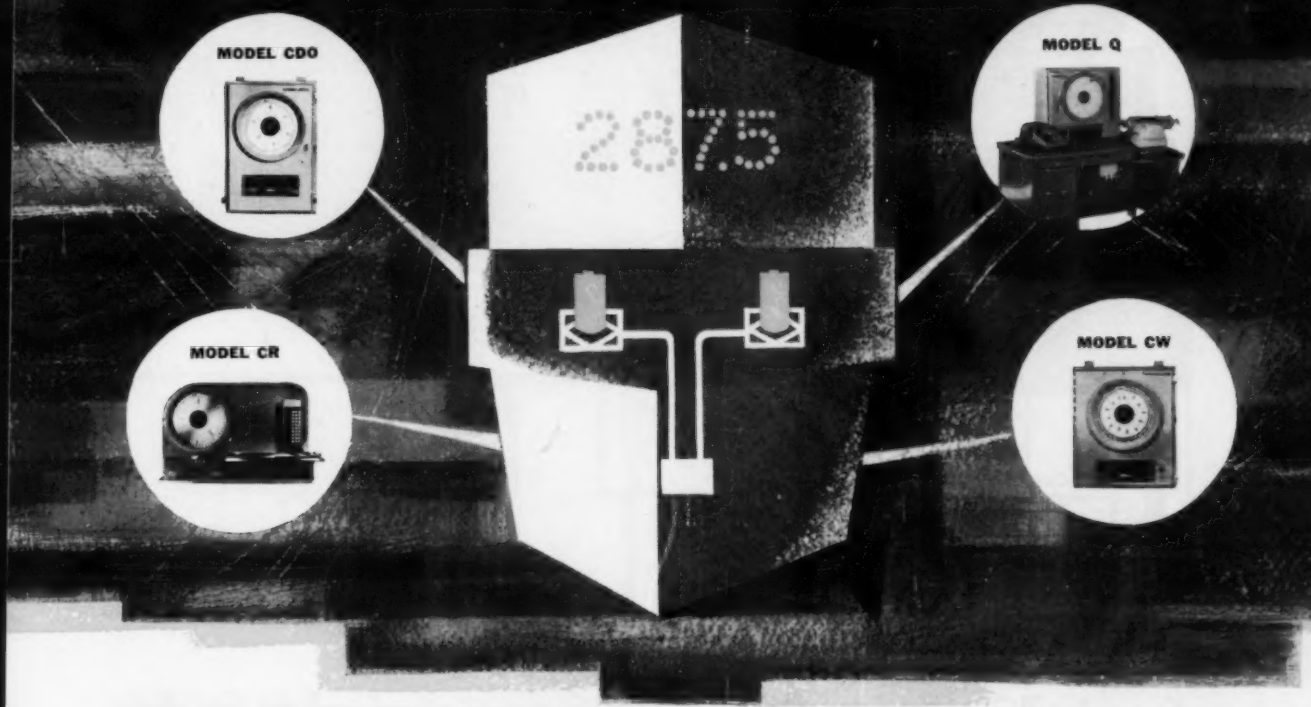
FILTER-COLLECTORS FEATURE PREASSEMBLED SOCK-CASE CONSTRUCTION

Design of these filter-collectors eliminates three major shortcomings of existing dry dust filters. These are: The excessive downtime required to replace worn socks, the difficulties encountered in entering the unit to replace filter bags, and dust leakage around bag frames. The Trans-Vair filter-collectors operate on high or low pressure impulse air controlled solenoid valves and are actuated either manually or by an electrical timer. They are available in three standard models covering 18 different capacity ranges with filter area from 6.8 to 368.4 sq ft. Custom designs are available for different dry dust filter-collector problems. **Young Machinery Co. Inc.,** Muncy, Pa.

Circle 411 on Reply Card

NOW FAIRBANKS-MORSE RECORDS WEIGHTS ELECTRONICALLY!

four F-M instruments solve weighing problems with greater speed...accuracy...flexibility



Four Fairbanks-Morse Electronic Weight indicating instruments, for use with an F-M Electronic Weighing System (either Full Electronic or Levetronic) enable you to choose the model that is best suited to your particular weighing needs. Each of these models offers fast, accurate weight indication. Each can be located up to 500 feet from the weighbridge.

Important features of these electronic weight indicating and recording devices are *automatic balance detection* (at true balance the instrument is automatically deactivated), *hold or memory circuit* (indicator can be held at last weight taken until a new weight is taken . . . is not forced to return to "zero"), *and automatic ranging* (an exclusive F-M feature that provides direct reading of weights. No mental calculations or mechanical manipulation are required. Original chart capacity is automatically expanded up to nine times).

There is a model for your particular needs:

MODEL CDO—For use where data processing equipment is used. Interprets weights and associated data, thus broadening the scope of work performed by all equipment.

MODEL Q—Provides the fastest weight indication of all F-M models. Ideal for your weighing-in-motion of single items in succession. Like the CDO, this model is for use where data processing equipment and office machines are used.

MODEL CR—A standard, table-mounted instrument with net-gross switch, selective "weigh" and "print" buttons, balance knob, direct-reading tare and standard printer.

MODEL CW—Similar to Model CR except that this model is designed for uses where printing of the weights is not required.

Since weighing plays an important part in your operations, you should seriously investigate automating this often-neglected area. Automation with F-M electronic equipment offers the benefits of time, labor and material savings . . . important money savings that can add substantially to your profits.

For further information, write: Joe Peterson, Sales Manager, Electronic Weighing Department; Electronics Division; Fairbanks, Morse & Co.; 100 Electra Lane, East Station; Yonkers, New York.

ELECTRONICS DIVISION
FAIRBANKS MORSE
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY

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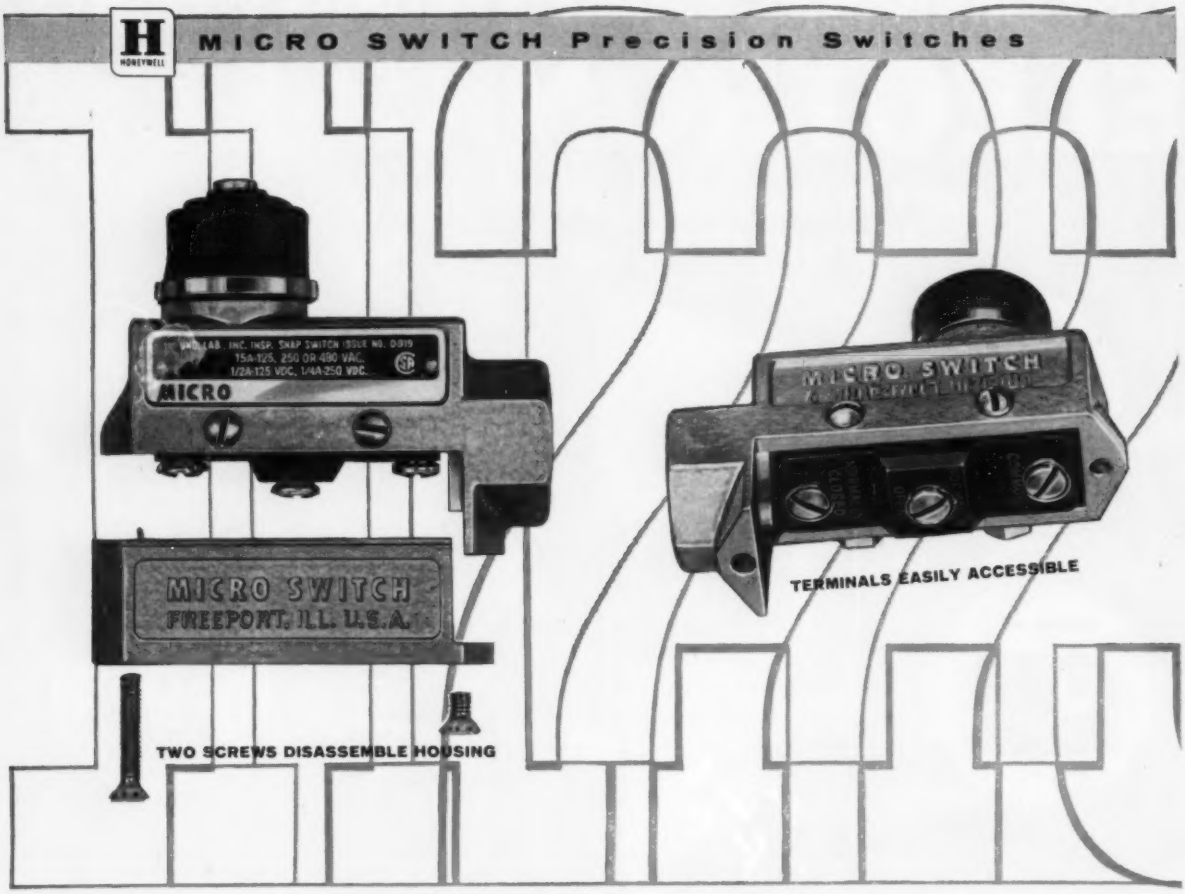
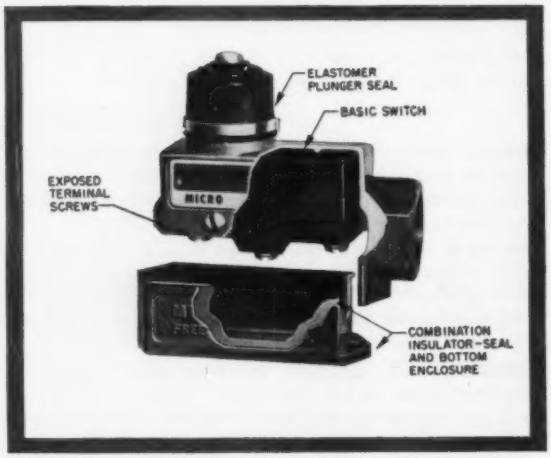


Now...fast, easy wiring in

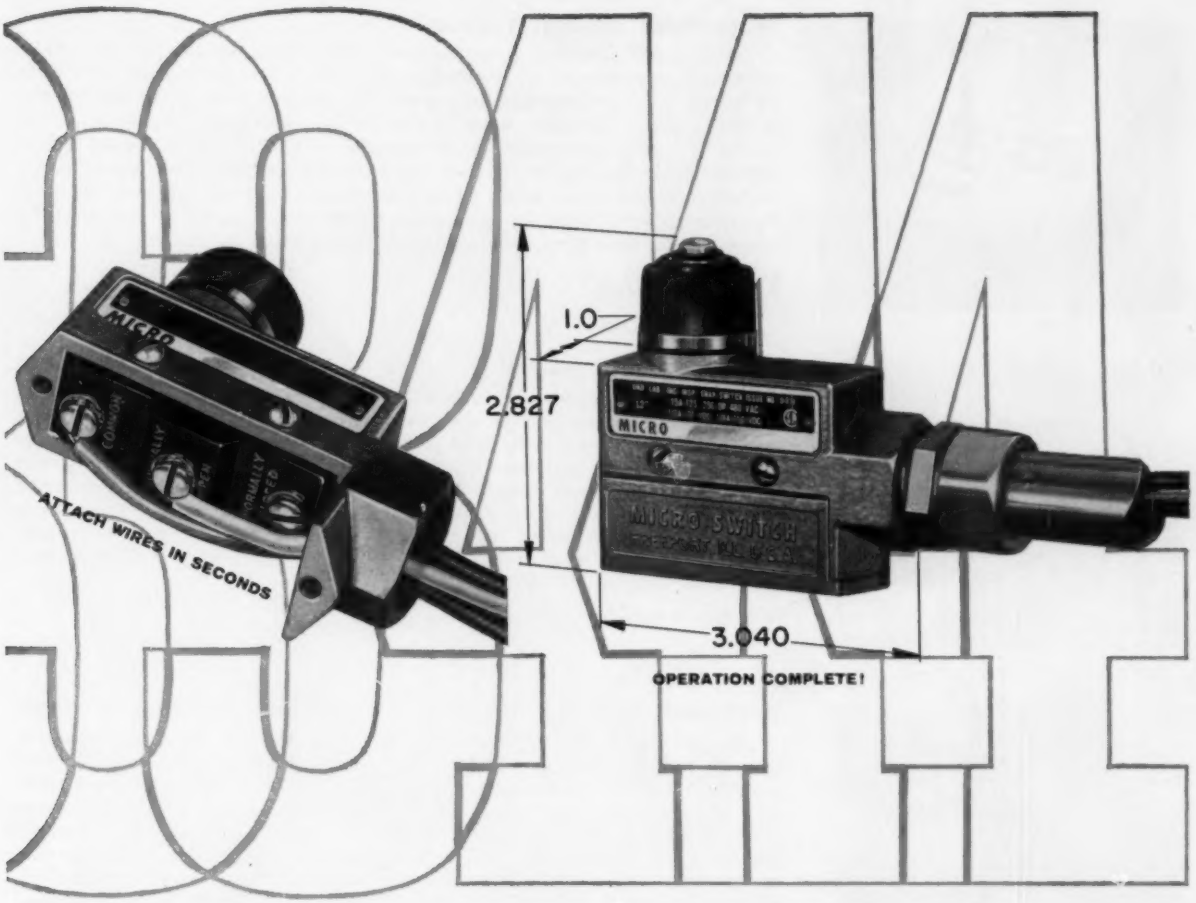
Quick and easy...a few turns of the screwdriver put switch terminals out in the open for fast wiring. The combination insulator-seal liner is permanently fastened in the bottom half of housing—can't drop out, be forgotten, or installed wrong. Even the conduit hub is hex-shaped for faster installation.

The extra-rugged "E6" and "V6" die-cast housings are sealed against dirt and oil splash. The basic switch is built for MICRO SWITCH precision action for millions of operations.

You can get these small easy-to-use switches from your nearby authorized distributor of MICRO SWITCH products. He stocks a full line of snap-action switches with a wide range of actuators and operating characteristics. See the Yellow Pages.



WRITE FOR CATALOG 83-20 PAGES OF HELPFUL INFORMATION ON ENCLOSED SWITCHES



"E6" and "V6" enclosed switches

8 DIFFERENT ACTUATORS—IN SIDE OR BASE MOUNTING DESIGNS

OVERTRAVEL PLUNGER

ELASTOMER SEALED PLUNGER

SEALED ROLLER ARM

CROSS-ROLLER PLUNGER

ROLLER PLUNGER

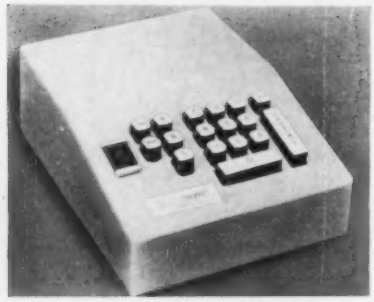
ONE-WAY ROLLER ARM

ROD ACTUATOR

ROLLER ARM

MICRO SWITCH, FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

H HONEYWELL **Honeywell**
MICRO SWITCH Precision Switches



PHOTOELECTRIC NUMERIC KEYBOARD

Model K-110 numeric keyboard features a photoelectric encoding technique which permits the generation of any standard or special 5, 6, 7, or 8-bit binary code, while eliminating all of the reliability limiting encoding matrices, contacts, and switches used in other available keyboards. It has 10 numeric keys plus 5 special function keys. The number of special function keys can be expanded to 20 if necessary. Typical applications of the keyboard include: Business data processing, communications, process control, machine tool control, automatic testing and checkout, and telemetry data reduction. Ten channels are available for any combination of binary code signals, and signals for tab, shift, etc. **Invac Corp.**, 14 Huron Drive, Natick, Mass.

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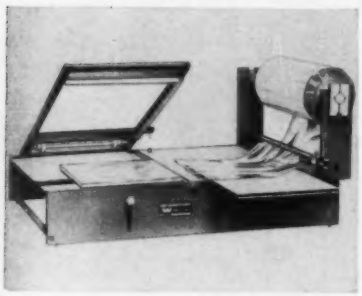

MULTISEAL IMPULSE SEALERS

Line of Type L right angle multiseal impulse sealers produce packages directly from V-folded poly roll stock or from shrinkable films. They heat and cool extremely fast, resulting in clean, strong seals. These thermal impulse units require very little power. Power is on only for the instant in which a seal is made. Sealers use plain or printed films and form bags up to 14 by 20 inches. In operation, an operator inserts product into V-folded film. One side is sealed simultaneously with previous package. The operator presses handle and remaining sides are sealed instantly. Cutoff is automatic. Portable, bench-type machines have brakes to adjust tension on roll holders. **Weldotron Corp.**, 841 Frelinghuysen Ave., Newark 12, N. J.

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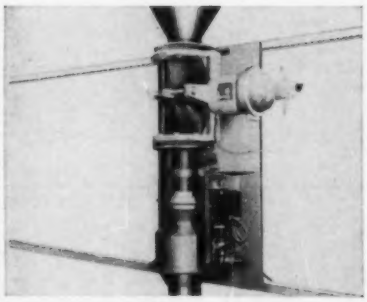


CONTINUOUS WEIGHT CONTROLLER FEATURES AUTOMATIC CONTROL OF WEIGHT

Designed for dry-flow processes, IPI Flo-Weight controller offers an accuracy of ±1 per cent. It permits automation of any dry-flow process or combination dry-flow and liquid process. The controller is a combination of a pneumatically operated pinch valve and a precision dry-flow meter, which is constantly weighing the dry-flowing material. Any variation in a previously selected flow rate automatically results in a signal from the meter to the pinch-valve controller to correct rate of flow. If desired, flow rate may also be recorded and/or totalized. This weight controller is available to fit spout sizes from 2 to 14 inches, with capacities from 10 to 3500 lb per minute. **Industrial Powertronix Inc.**, 535 N. W. 11th Ave., Portland 9, Oreg.

Circle 414 on Reply Card

HOT TRANSFER LEAF PRINTER

Solenoid controlled, air operated unit has been developed to apply sharp, clear, indelible imprints on polyethylene bags. It uses heated metal type and a hot printing head to permanently transfer the thermoplastic die imprint from a roll of tape to a bag. Automatic leaf feed is completely adjustable as is the heat and dwell control. Regulation of temperatures and time helps prevent sealing of the bag during the hot imprinting cycle. After insertion into the throat of the machine, the bag is automatically positioned by the printer which then imprints a code number, product identification or other information. **Industrial Marking Equipment Co. Inc.**, 655 Barriman St., Brooklyn 8, N. Y.

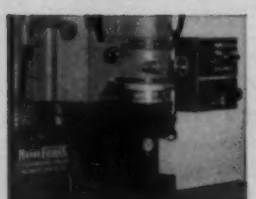
Circle 415 on Reply Card

VERSATILE INDEX UNIT FEATURES HIGH LOADING SPEED TORQUE CAPACITIES

Pre-engineered indexing drive unit has been developed for adaptation to cycling precision conveyors, transfer chassis, and dial indexing machines. Cam and roller internal components provide an ideal modified trapezoid acceleration pattern for smooth and shockless indexing. These cams provide indexing accuracy within 0.001 inch on a 12-inch diameter sprocket or dial. Drive unit has a torque range of 25,000 pound inches. Higher torque models are also available. Standardized drives are available with a wide selection of output shaft angular movements from 4 to 24 stops. Indexing periods are available in 90, 120, 180, and 270 degrees to permit selective cycle timing of index and dwell. **Visi-Trol Engineering Co.**, 12720 Burt Rd., Detroit 23, Mich.

Circle 416 on Reply Card

NUMERICAL CONTROL FOR PRODUCTIVE PRECISION BORING



Fosmatic numerical control is also available on Moore-Fosdick jig grinders.

FOSMATIC N/C PRECISION BORING MACHINES

Four models from the compact "32" with 18″ x 30″ table travel, to the big "54" with 28″ x 48″ travel. All available with Fosmatic electro-mechanical tape control for table position, spindle depth, head height, speeds, feeds, and tool changing. Fosmatic control positions workpieces accurately to ± .0001″. Fosmatic jig borers make provision for numerical control in the basic design and can be furnished in any degree of automation.

Get a proposal from

The Fosdick Machine Tool Co., Cincinnati 23, Ohio

FOSDICK

Circle 684 on Reply Card

ELECTRIC INFRARED HEATING PANELS AND OVENS

Line includes electric quartz infrared heating panels, elements, and engineered oven assemblies for application in process heating. Quartz infrared elements are available in 22, 46, and 70-inch over-all lengths with wattage ratings from 500 to 1500 watts for 115 volt elements and 500 to 3500 watts for 230 volt elements. At normal line voltage, the quartz infrared elements operate at approximately 1600 F, with peak emission at 3-3.5 microns. Heater panels are supplied for both front and back wire connections. They are made to accommodate one, two, and four elements and are made in two, four, and six-foot lengths. Electric infrared oven assemblies are used in heating, drying, curing, and baking applications in the chemical, metal, plastic, wood, rubber, and other industries. **Fannon Products Div., Hupp Corp.**, 3000 E. Woodbridge, Detroit 7, Mich.

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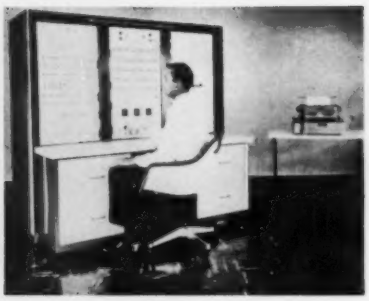

SOLID-STATE GENERAL PURPOSE COMPUTER FOR MEDIUM SIZE MARKET

Digital Data Processor (DDP) is especially designed for engineering problems, including real-time simulation, control of high-speed target precision tracking, and real-time test data acquisition. It has a 19 to 25 bit range. This single address, parallel, binary, stored program machine has an input-output flexibility provided by up to 16 input-output channels under program control. Each input-output unit can be operated in either a busy or demand mode. Unit features an interrupt mode for real-time operations, a list of 64 commands, and an index register. Optional inputs include a paper tape unit, a Flexowriter, magnetic tape, and card reader. Optional outputs include paper tape punch, typewriter, incremental plotter, high-speed line printer, and magnetic tape. **Computer Control Co.**, 2251 Barry Ave., Los Angeles 64, Calif.

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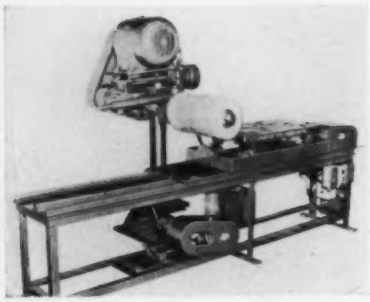

RECIPROCATING STRAIGHT LINE BUFFING MACHINE

Automatic buffing machine has been developed for buffing and satin finishing surfaces of flat shaped parts such as stainless steel stove, table and sink tops, brass nameplates, kick plates, and grille work. It consists of an oscillating workholding fixture mounted on a reciprocating platen. A floating head fully adjustable heavy duty buffing lathe performs the finishing operations as the part is reciprocated and oscillated under the buffing wheel. A solenoid operated timer control permits the work to reciprocate under the wheel for a predetermined time cycle. The oscillating fixture provides uniform wheel wear, eliminates buff streaking, and permits the use of the buffing lathes that do not incorporate stroking type-spindles. **Acme Mfg. Co.**, 1400 E. Nine Mile Rd., Detroit 20, Mich.

Circle 419 on Reply Card

TAPE CONTROLLED CIRCUIT BOARD DRILLING MACHINE

Designed to drill printed circuit boards of a wide variety of materials and thicknesses, this machine consists of a tape controlled positioning table and 4 drilling clusters, each with 4 independent air feed drill units. These air feed drill units may be fitted with different size drills and rotated at different speeds up to 22,000 rpm. The positioning table has a travel of 14 by 20 inches at 200 inches per minute and a flat working surface of 18 by 44 inches. Maximum drilling pattern varies according to the number and size of the drills being used. With 2 size drills in each of 2 clusters, the maximum pattern is 14 by 18 inches or 12 by 20 inches; with 4 drills in each of 4 clusters the maximum pattern is 10 by 12 inches. **Edlund Machinery Co.**, Dept. P-CB, Cortland, N. Y.

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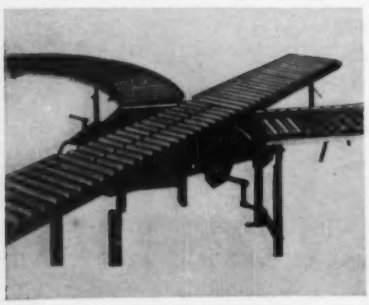
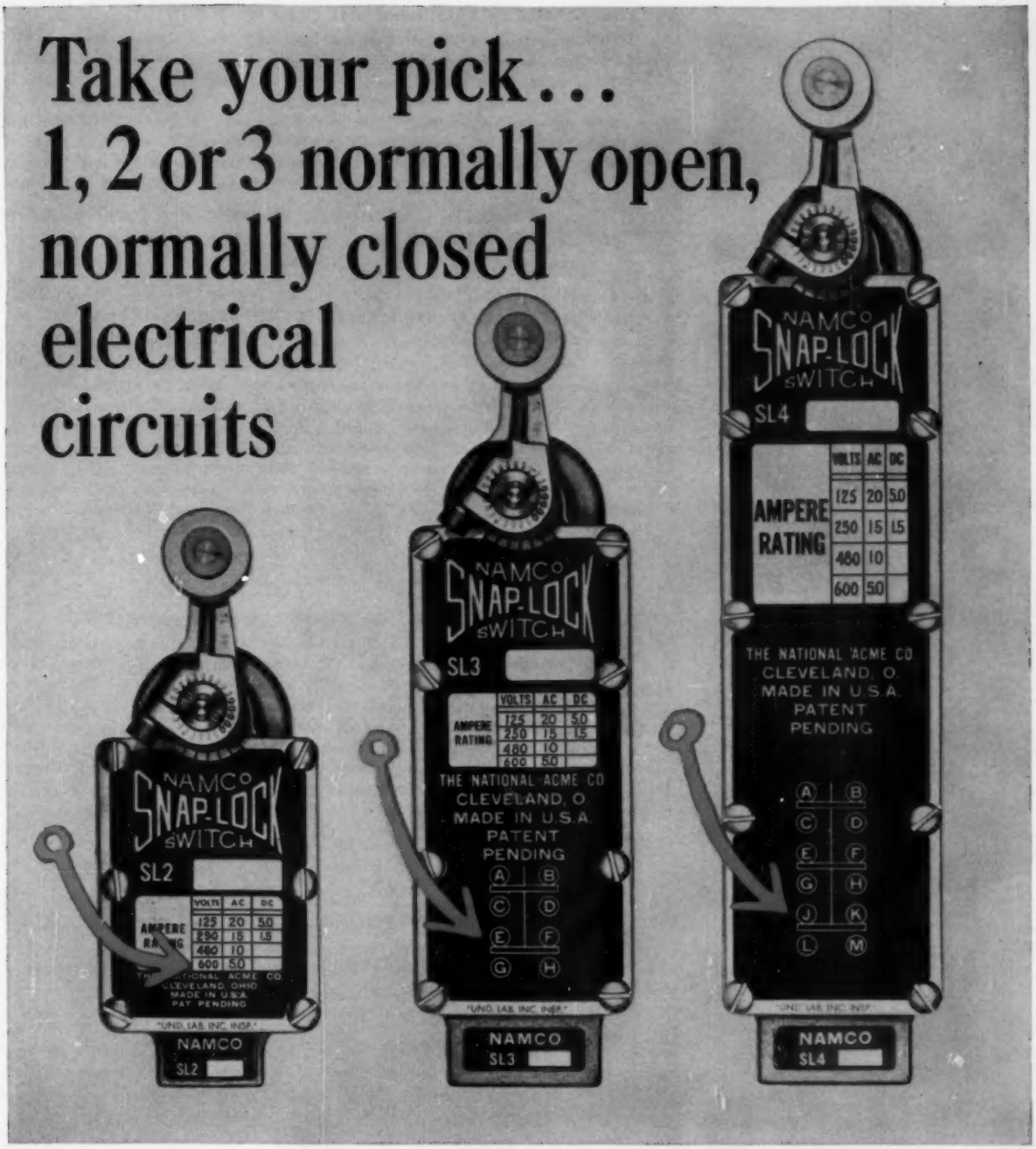


FLEXIBLE ROLLER CURVE UNITS MAKE CONVEYOR SYSTEMS MORE VERSATILE

Units have been developed for switching conveyorized items onto spur lines left, right, or straight ahead (illustrated). Models for three-way, "Y", or spur switching are available. Units connect to gravity or power conveyors and are operated by hand, or by motor from remote locations. Three-way switch models enable material from any three lines to be channeled onto a common line. The "Y" switch diverts materials to right and left spur lines only. Spur switch model has straight-through and either right or left hand position turn. These flexible roller curve units are for 12, 18, or 24-inch conveyors. They are designed with rollers in two lanes to assure material alignment around curves. **Rapids-Standard Co. Inc.**, 342 Rapistan Bldg., Grand Rapids, Mich.

Circle 421 on Reply Card

Take your pick... 1, 2 or 3 normally open, normally closed electrical circuits

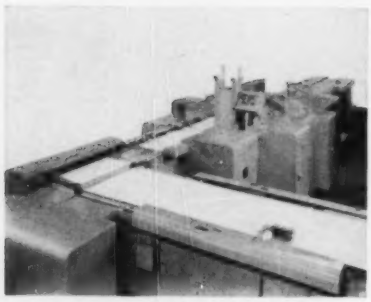


What does your limit switching application call for . . . one, two or three normally open, normally closed electrical circuits? Whatever it is, one of these National Acme SL "Machine Life" Limit Switches . . . the SL2, the SL3 or the SL4 . . . will meet your precise requirement. And, every SL offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (10½ lbs. at 1½" radius). Also available . . . the SLS 2, 3 or 4 featuring "hi-shock" sliding contacts; particularly suitable for drop forge, punch press and other heavy equipment application. Call, write or wire for complete information.

National Acme

THE NATIONAL ACME COMPANY
196 E. 131st STREET
CLEVELAND 8, OHIO

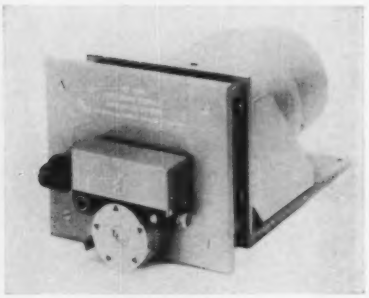
Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.



MACHINE CAPABLE OF CARTONING 7056 CUBES PER MINUTE

Horizontal type Nova Motion Cartoner feeds and opens a carton automatically, places the carton in an intermittently moving conveyor, elevates the previously oriented 196 single sugar cube tier into 4 tiers of 49 cubes each, and loads them automatically while the carton conveyor is in the *Rest* loading position. Flaking off of sugar granules is prevented through the use of stainless steel infeed belts for gentle handling of the cubes. This cartoning machine offers adjustable capacity to accommodate a range of 1 through 2-lb cartons. It provides for the gluing of a special gusset and web corner at one end of the carton and a standard seal end at the other. **R. A. Jones & Co. Inc.**, P. O. Box 485, Cincinnati 1, Ohio.

Circle 422 on Reply Card



MODULAR DESIGN BLOCK TAPE READERS

Series of block tape readers were developed for use where panel space is at a premium. One or more of the three 400-series reader subassemblies may be combined with a single 400-series control unit to make up a tape reader for 80, 96, or 120 bit tape frames, or all three selectively depending on the models of reader subassemblies employed. All models read standard 8-level perforated tape with no special punch required. The 410-series reader is an 80-bit unit; the 412, 96-bit; and the 415, 120-bit. Combined with the 400-series control unit, they make up the following models respectively: TP-450, TP-452, and TP-455 tape programmers. **Automation Div., Electronic Engineering Company of California**, 1601 E. Chestnut Ave., Santa Ana, Calif.

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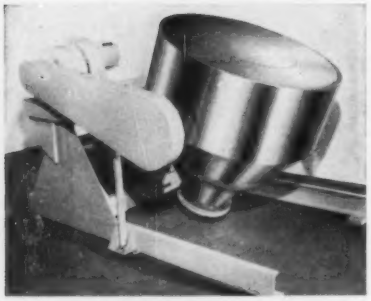

MIXER AVAILABLE WITH VARIETY OF SCREENS FOR MANY PARTICLE SIZES

Featuring a new mixing and blending principle, the Strata Screen mixer has wide application in the food, chemical, and other processing industries. It is designed to increase the speed of mixing and blending dry solids over conventional double cone mixers. The combination of gentle dispersing action together with shorter mixing time avoids the tendency of particle breakdown thus preserving uniformity of size where this is a critical requirement. The mixer can also blend particles of different weights, without regard to differing specific gravities. It has an optional hydraulic elevating feature which makes floor level loading and unloading possible. Mixers with ½, ¼, ⅛, and 1/16-inch slotted screens are available. **Hobam Inc.**, Box 91-172, Buffalo 17, N. Y.

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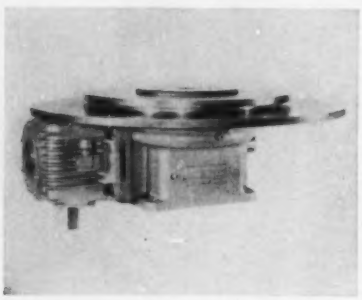

INDEX TABLE DESIGNED TO GIVE PRECISION PERFORMANCE ON LARGE JOBS

Heavy duty, high-speed Series A index table has an accuracy of 0.001 inch on a 28-inch diameter. It handles loads of 24,000 inch-pounds and over with high accuracy. Features include a Timken bearing near outside of diameter of cam follower plate for increased stability; immediate adaptability to dial plate of user's choosing; and a hollow shaft that enables air, fluids, coolants, or additional tooling to be brought directly to center of work area. This index table supports dial plate load of 18,000 pounds and has machined housing surfaces for mounting tooling plates. It permits shaft mounted speed reducers to be fitted directly. Zero backlash is maintained in dwell position. **Commercial Cam & Machine Co.**, 455 N. Artesian Ave., Chicago 12, Ill.

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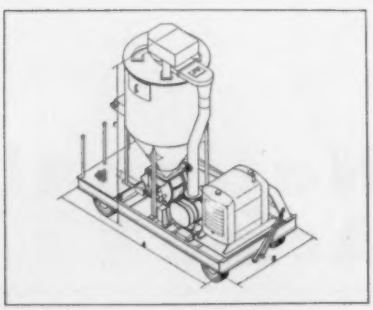

CONTINUOUS FILTER-TYPE PORTABLE TRANSFER UNIT

Available for 3 and 4-inch conveying lines, Airveyor continuous filter-type portable transfer unit has been designed for dense-stream pneumatic conveying of dusty materials. It will handle a wide range of milled and pulverized materials, such as cracked grains, meals, feeds, flour, sugar, salt, salt cake, clay, soda ash, lime, polymers, etc. Principal design feature of the unit is a completely automatic filter. The elements of this filter are cleaned continuously by a single master valve driven by a ⅛ hp motor. **Fuller Co.**, Catasauqua, Pa.

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. . . for one thing, they're kicking yesterday's production costs into a cocked-hat.

What's more, it's the pushbutton automated foundry that is supplying automotive manufacturers with connecting rods, crank and cam shafts. It's the pushbutton foundry that can meet the price and delivery demands of the plumbing and appliance industries.

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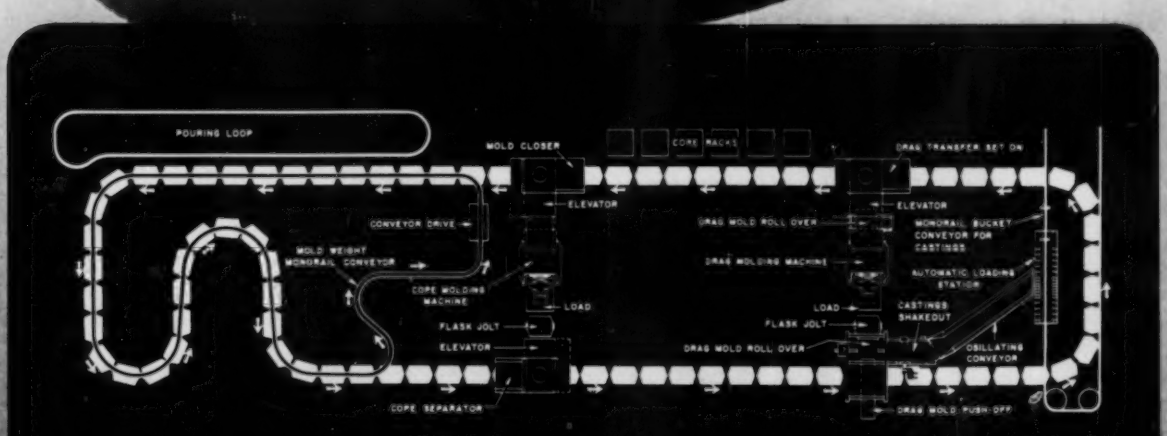

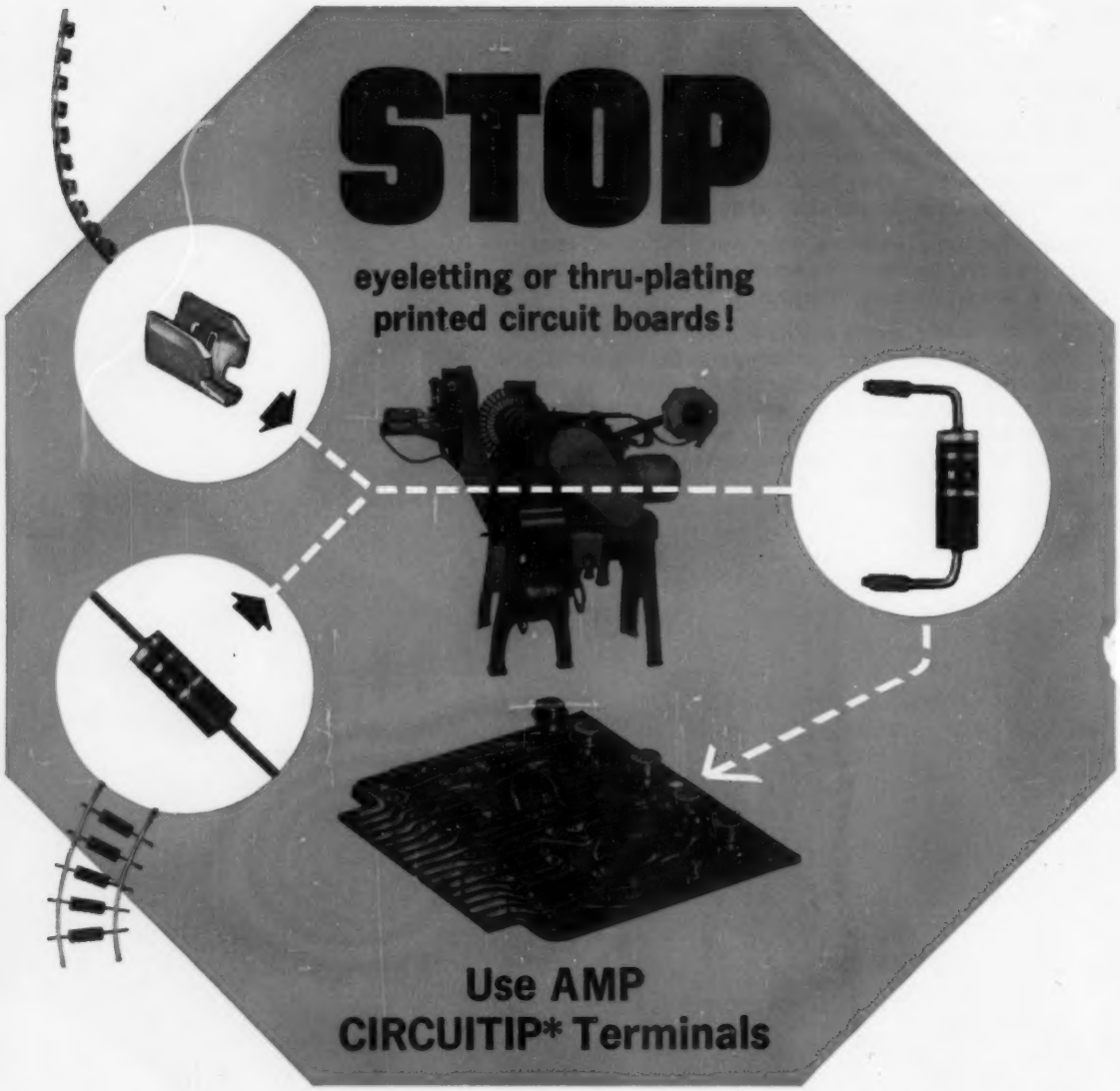

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AUTOMATION

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PRODUCT INDEX

Actuators, 133
Adjustable speed drives, 5, 8, 40, 106-107
Air
  compressor, 104
  cylinders, 17, 117, 143
  lubricators, 113
  motors, 113
  valves, 1, 11, 36, 102, 115, 131, 136
Assembly machines, 85, 96, 128, 137

Ball screws, 133
Batching, 38, 112, 146
Bin level control, 143
Blending, 38, 112
Boring machine, 122
Brakes, 29, 126
  magnetic, 141
  systems, 128
Building block units, 35, 113, 138

Calculator, desk, 82
Card reader, 12
Checkweigher, 118, 146
Clutches, 29, 126
Coating system, 24
Coil
  handling equipment, IFC
  winder, 146
Compressors, air, 104
Contouring machine, 32
Control
  conveyor, 26-27, 122
  systems, 35, 104
  tape, 25
Controls
  counting, 105, 106, 107
  digital, 105, 106, 107
  feed load, 146
  level indicating, 104, 119, 143
  liquid level, 119
  remote, 121
  sensing & switching systems, 119, 139
  spray machine, 81
Conveyor
  diverter, 26-27
  scale system, 112
Conveyor controls, 26-27, 122
Conveyor systems, IFC, 15, 134
  overhead, 31, 109
  pallet, 143
  pneumatic, 104
  steel belt, 116
  vibratory, 140
Counting controls, 105, 106, 107
Coupling, 40
Cylinders
  air, 17, 117, 143
  hydraulic, 17, 117, 143

Dc drives, 40
Digital control, 105, 106, 107
Directional control valves, 20-21
Diverter, conveyor, 26-27
Drilling machines, 122
Drill units, 113
Drives
  adjustable speed, 5, 8, 40, 106-107
  dc, 40

Electric heaters, 125
Elevator feeders, 120
Engineered drive systems, 5, 8

Fastening tool, 22
Feasibility analysis, 123
Feeders
  elevator, 120, 140
  parts, 120
  vibratory, 120, 130, 140
Feed load controls, 146
Filters, 113
Finishing system, 24
Flow control valve, 1, 11
Foundry systems, 95

Gaging, 26-27

Handset, telephone, 28
Heaters
  electric, 125
  infrared, 125, 132
  pipe & tubing, 142
Hoist, 113
Hydraulic
  cylinders, 17, 117, 143
  motors, 111
  power units, 20-21, 129
  pumps, 20-21, 111, 129
  valves, 1, 5, 11, 20-21, 36, 102, 115

Indexing units, 85, 96, 128, 137
Industrial recorder, 123
Infrared
  heating, 125, 132
  sensing, 139

Jig boring machine, 91

Level indicating controls, 104
Limit switches, 88-89, 93, 142
Liquid level controls, 119
Lubricators, air, 113

Machine tools, 32
  boring, 122
  contouring, 32
  drilling, 122
  jig boring, 91
  milling, 32
  milling, programmed, 6-7
  numerically controlled, 32
  profiling, 32
Machines
  assembly, 85, 96, 128, 137
  molding, 95
  terminal application, 96
  transfer, IFC, 2, 39
  welding, IBC
  wire cutting & stripping, 30, 124
Magnetic brakes, 141
Manufacturing engineering service, 123
Marking machine, printer, 110
Measuring, lineal measuring system, 105, 106, 107
Mechanized foundry systems, 95
Meter, relays, 114
Milling machine, 32
Milling machine, programmed, 6-7
Molding machines, 95
Motors
  air, 113
  electric, 141
  hydraulic, 111
  servo, 108

Numerical controls, 101
Numerically controlled machine tools, 32
  boring, 122
  drilling machine, 32
  jig boring, 91

Overhead conveyor system, 109

Packaging, 23, 146
  strapping, 19
Painting system, 24
Parts
  feeders, 120
  washer, 143
Pilot controlled valves, 1
Pipe, electrically heated, 142
Plug-in programming, 6-7
Power units, hydraulic, 20-21, 129
Profiling, machine, 32
Programmer, 142
Pumps
  hydraulic, 20-21, 111, 129
  vacuum, 104
Pushbutton, 26-27

Reader
  cards, 12
  tape, 28
Readout, 87, 112
Recorder
  industrial, 87, 112, 123
  tape, 28
Relays, meter, 114
Remote controls, 121

Screwdriving tool, 22
Screws, ball, 133
Sensing & switching system, 119, 139
Servo
  motors, 108
  speed control, 35
Solenoid valves, 1, 20-21, BC
Speed drives, adjustable, 5, 8, 40, 106-107
Spray machine, 81
Strapping machine, 19
Switches
  card reader, 12
  limit, 88-89, 93, 142

Tape
  coding system, paper, 28
  control, 25
  reader, 28
  recorder, 28
Tape controlled machine tools, 32
  jig boring, 91
Telephone handset, 28
Terminal application machine, 96
Terminals, 96
Tools, fastening, 22
Transfer
  machines, IFC, 2, 39
  systems, 138
Tubing, electrically heated, 142

Valves
  air, 1, 11, 36, 102, 115, 131, 136
  directional control, 20-21
  flow control, 1, 11
  hydraulic, 1, 5, 11, 20-21, 36, 102, 115
  pilot controlled, 1
  solenoid, 1, 20-21, 136, BC
Vibratory feeder, 120, 130, 140

Warehouse system, 148
Washer, parts, 143
Weighing, 38, 87
Weighing & feeding, 38, 112, 118, 146
Weight recorder, 87, 112
Welding machine, IBC
Wire cutting & stripping, 30, 124

AUTOMATION

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INDEX OF EQUIPMENT BY ITEM NUMBERS

(New Equipment, New Components, and New Literature covered in this issue)

Actuators
rotary, 429, 444
rotary torque, 453
Air dehydrator package, 431
Amplifier, photocell, 448
Analyzer, pH, 461
Assembly machines, 486

Batching control panel, 405
Brakes
disc, 479
magnetic, 434
Brushing tools, 467
Buffing machines, 419

Calculator, shear, 462
Cams and camshafts, 480
Cartoning machine, 422
Center-of-gravity locators, 483
Circuitry, digital, 474
Cleaners, air, 431
Clutches, miniature slip, 438
Collator, punched card, 402
Computers
digital, 418
flow ratio, 428
Contactors, 451
Control center, process, 470
Controllers
process, 443
program, 443
Controls
batching, 405
mixing, 405
pneumatic, 491
weight, 405, 414
Conveyor roller curve units, 421
Conveyor systems, 485
Conveyor transfer unit, 426
Conveyors, 490, 497
horizontal carousel, 404
Counters
electronic, 455, 463
electronic impulse, 437
Cylinders, pneumatic, 491

Data acquisition systems, 465, 481
Data processing
analog to digital converters, 465, 481
computers, 418
interrogator systems, 477
memory, 450
numerically controlled drill, 401
photoelectric numeric keyboard, 412
punched card collator, 402
readout control system, 409
tape controlled circuit board drill, 420
tape controlled turret drills, 493
tape readers, 423
Data scanning relays, 430
Data system, shop control, 409
Destacker, vacuum, 407
Detector, infrared, 456
Digital circuitry, 474
Drilling machine, tape controlled circuit board, 420
Drills
numerically controlled, 401
tape controlled, 493
turret, 493
Drive unit, indexing, 416
Drives
clutches, 438
magnetic brakes, 434
Dryer, air, 431

Electrical components, 427, 430, 433, 434, 447, 451, 457, 460, 466, 478, 479, 484, 489

Feeders, vacuum, 407
Filter-collectors, 411
Finishing
buffing machines, 419
Flow ratio computer, 428
Flow regulators, liquid, 441

Gas data, industrial, 472
Gas density cells, 454
Gearmotors, single reduction, 457

Handling
conveyor roller curve units, 421
conveyor system, 485
conveyor transfer unit, 426
conveyors, 404, 490, 497
destacker, 407
feeders, 407
materials, 497
uncaser, 482
Heating panels, infrared, 417
Heating unit, induction, 485
Hydraulic components, 435, 441, 452, 455, 487
Hydraulic power packages, 487

Index table, 425
Indexing drive unit, 416
Indexing units, cam-operated, 495
Induction heating unit, 466
Infrared detector, 456
Infrared ovens, electric, 475
Instrument controls, 429, 437, 439, 444, 453, 458, 461
Instrument indicators, 492
Interrogator systems, 477

Keyboard, photoelectric numeric, 412

Limit switches, 427

Machine attachments
indexing unit, 495
Machine tools
circuit board drill, 420
drills, 401
shears, 462
tape controlled turret drills, 493
Machines
assembly, 486
buffing, 419
cartoning, 422
filter-collectors, 411
glass to metal sealing, 410
index table, 425
infrared ovens, 475
mixer, 424
ovens, 417
stud driving, 408
web tension unit, 403
welding, 406, 486
Marking
bag printer, 415
Measuring
center-of-gravity locators, 483
displacement transducer, 436
flow-ratio computer, 428
gas density cells, 454
liquid, 463
pH analyzer, 461
photocell amplifier, 448
rotary motion transducers, 473
strain gages, 469
thickness gage transducer, 436
time indicators, 492
timers, 449
Memory twistor, 450
Meter-relay circuits, 484
Meters, elapsed time, 492
Mixers, dry solids, 424
Mixing control panel, 405
Motors, pump, 478

Optical terminology, 464
Ovens, infrared, 417, 475

Packaging
cartoning machine, 422
multiseal impulse sealers, 413
Photocell amplifier, 448
Photoconductive cells, 442
Photoelectric
numeric keyboard, 412
relays, 440
Pneumatic components, 432, 435, 452, 455, 471, 491
Potentiometers, preset, 439
Power packages, hydraulic, 487
Pressure
switches, 460
transducer, 445
transmission devices, 468
Printer, polyethylene bag, 415
Process control center, 470
Production facilities, specialized, 486
Program controller, 443
Pump motors, 478
Pumps
dry powder, 446
explosion-proof, 435
hydraulic, 435
pneumatic, 435
proportioning, 455
Punched card collator, 402

Readers, tape, 423
Regulator, liquid flow, 441
Relays, 451
data scanning, 430
photoelectric, 440
Research and development service, 496
Roller curve units, conveyor, 421
Rotary actuators, 429, 444

Sealer, multiseal impulse, 413
Sealing machine, glass to metal, 410
Semiconductor devices, 494
Servo valves, 459
Shear calculator, 462
Strain gage, weldable, 469
Stud driving machine, 408
Switches
limit, 427
pneumatic control, 447
pressure, 460
pushbutton, 433
Switchgear, stored-energy, 489

Tape readers, block, 423
Tension unit, web, 403
Timers, pneumatic, 449
Torque actuators, rotary, 453
Transducers
displacement, 436
pressure, 445
rotary motion, 473
Transfer unit, conveyor, 426
Transmitters, pressure, 468

Uncaser, bottle, 482

Valves
ball, 471
ball and shuttle, 452
directional control, 488
pneumatic, 432, 491
servo, 459

Waste treating, industrial, 476
Web tension unit, 403
Weighing control panel, 405
Weight controller, 414
Welders, flash-butt, 406
Welding machines, 486

401-426—NEW EQUIPMENT—*page* 83 **427-461—NEW COMPONENTS—*page* 103**
462-497—CATALOGS & LITERATURE—*page* 127

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Page No. Title of Article

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403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854
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411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861
412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862
413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863
414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864
415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865
416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866
417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867
418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868
419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869
420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870
421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873
424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874
425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875
426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876
427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877
428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854
405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855
406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856
407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857
408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858
409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859
410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860
411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861
412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862
413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863
414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864
415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865
416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866
417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867
418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868
419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869
420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870
421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873
424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874
425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875
426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876
427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877
428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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Page No. Title of Article

....

....

Circle item number for further information on anything described or advertised in this issue

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COMPANY _____

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401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851
402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852
403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854
405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855
406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856
407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857
408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858
409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859
410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860
411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861
412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862
413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863
414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864
415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865
416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866
417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867
418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868
419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869
420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870
421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873
424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874
425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875
426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876
427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877
428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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Hughes Numerical Controls can help keep your up-time extremely high. In fact, customers report down-time of as little as 2% of productive time after thousands of hours in operation. (Ask any company that uses Hughes Numerical Controls.*) The reason: HUGHES RELIABILITY. Hughes' electronic engineering know-how combines transistorized circuitry, modular construction and photo-electric tape readers to achieve true RELIABILITY. This means lower operating costs, greater productivity and higher profits to you. If you can't afford down-time, get the facts. Find out more about RELIABLE Hughes Numerical Controls. Write, wire teletype (INGL 4117) or call direct: Hughes Industrial Control Systems, Dept. No. 92-21, P. O. Box 90904, Los Angeles 9, California.

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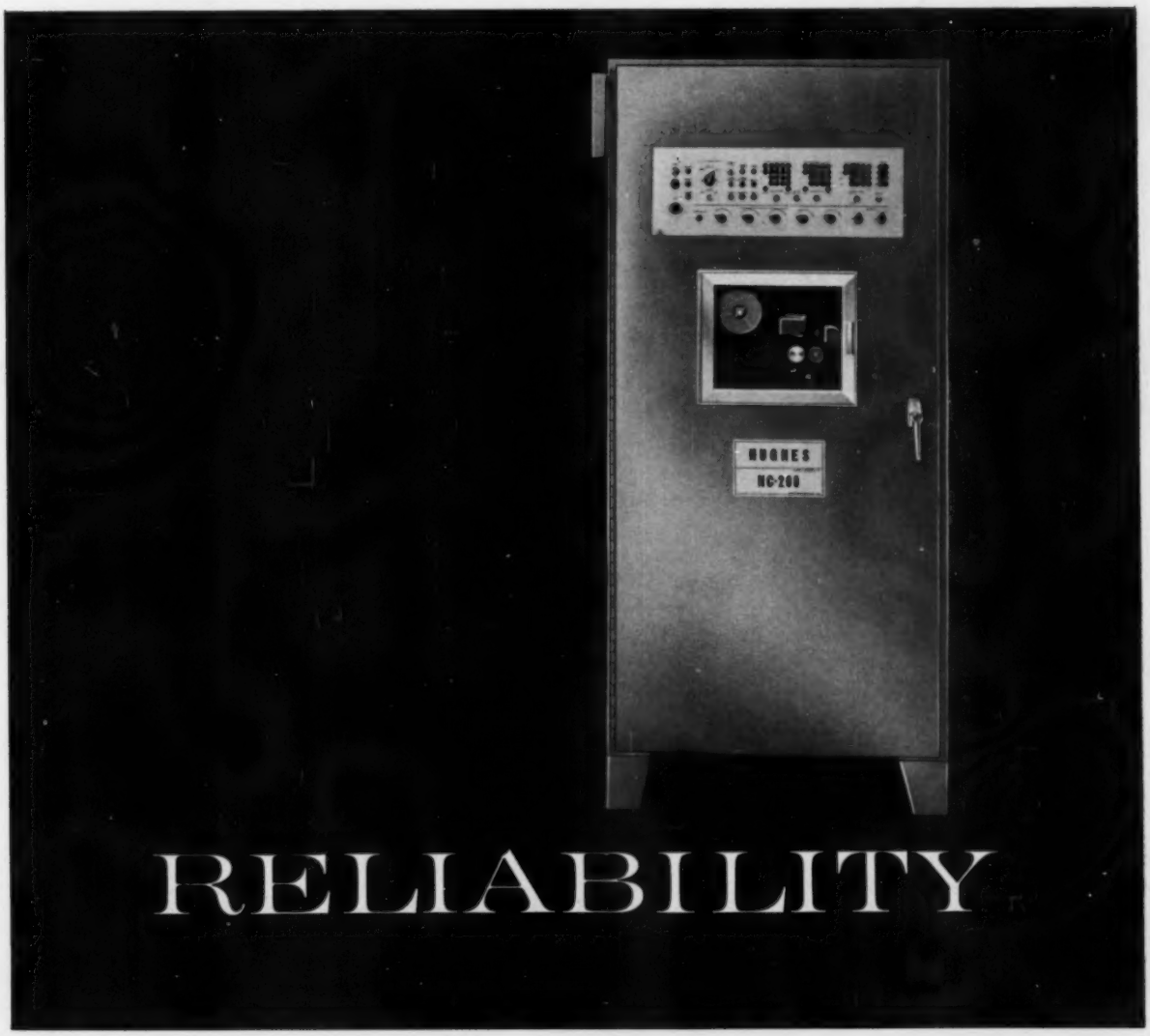
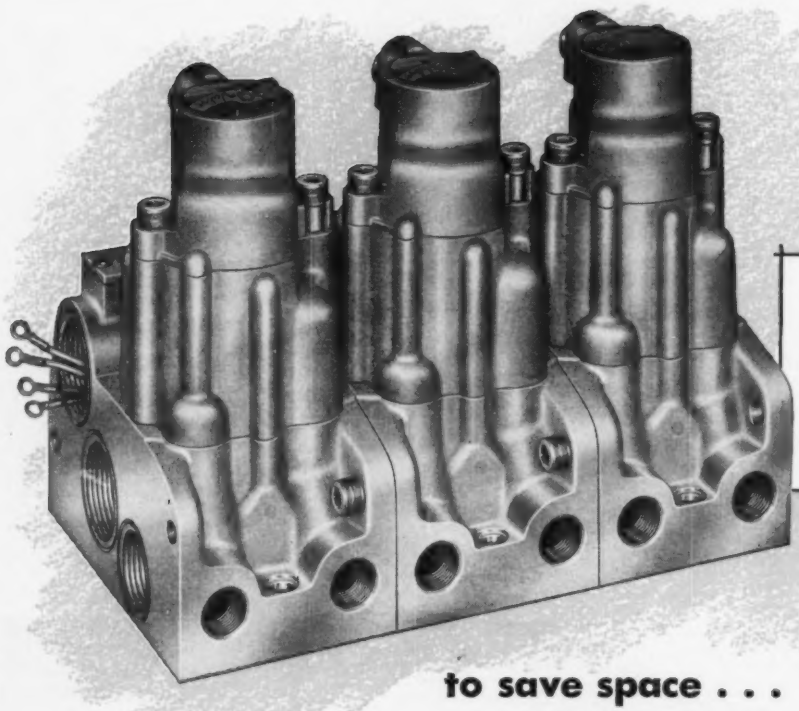
HUGHES AIRCRAFT COMPANY

INDUSTRIAL SYSTEMS DIVISION





Cylinder ports side and bottom tapped, ⅜, ½ or ¾ in. NPT; through ports tapped both ends and bottom, supply—1 in. NPT, exhaust and wiring conduit ports—1¼ in. NPT; meets JIC Standards.

to save space . . .

to simplify piping and wiring

PDQ MODULAR MANIFOLD BASE

Now you can save even more space by ganging already-compact Hunt ½ in. PDQ valves on modular manifold bases!

Featuring common supply, exhaust and wiring conduit ports, PDQ modular manifold bases can be ganged end-to-end to manifold two or more valves in a single, compact assembly. Manifolding of valves simplifies supply and exhaust piping, reduces installation costs and minimizes mounting space requirements for multiple valve installations. Modular design permits adding or removing valves at a later date, to meet changing requirements. Also, bottom tapping permits additional supply, exhaust, or wiring connections at any point along the manifold assembly, if required.

Electrical connections, valve-to-base, are plug-in, to reduce downtime to a minimum. What's more, the bayonet-lock construction of Hunt's PDQ valve allows removal and installation of valve and pilot assembly in just 30 seconds, without disturbing piping or wiring.

Whether your problem is limited valve mounting space . . . complex piping . . . high installation costs . . . or you're just looking for better, lower cost, more dependable performance on new or existing equipment, ask your nearby Bellows-Valvair representative to show you the advantages of modular manifold base-mounted PDQ valves.

3014-3

For more information, write for Bulletin 602. Address Bellows-Valvair, Pneumatics Division, Akron 9, Ohio, Dept. AU-1261.

Bellows-Valvair

Division of IBEC AKRON 9, OHIO

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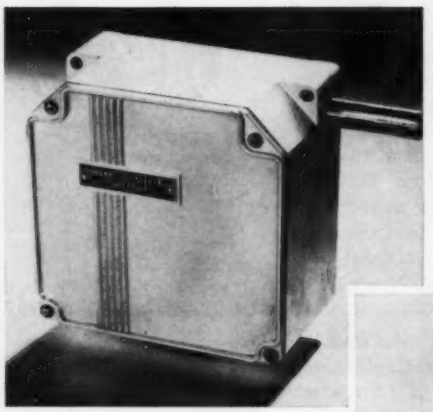
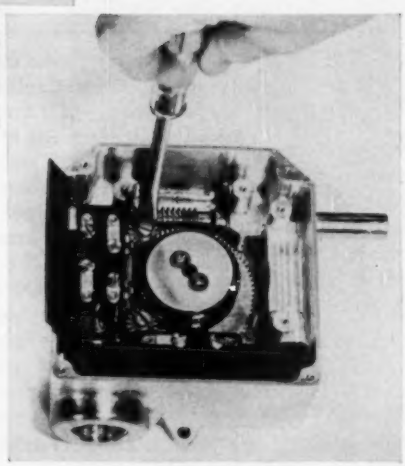
For detailed information and literature, use Readers' Reply Card.



Rotating-shaft limit switch is available in nine different gear ratios from 20:1 to 1280:1. This provides product flexibility and ease of adjustment. All gear ratios are provided with fast resetting action.



Switch may be adjusted by a worker utilizing only one hand with a screw driver. This is especially important when the switch is mounted on an overhead door or hoist and work must be performed from a stepladder.

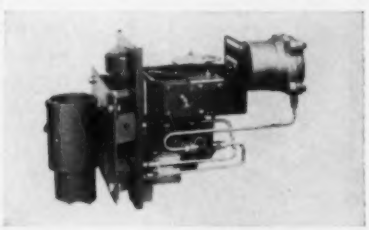
Rotating-Shaft Limit Switch

LIMIT switch, introduced by **General Electric Co.**, Schenectady 5, N. Y., is designed to measure the revolutions of a rotating drive shaft. It is ideal for stopping and starting overhead doors or hoists and for use on machine tools where rotary motion, instead of linear motion, must be sensed.

Cam adjustment of the CR115E switch may be performed with one hand. This is especially important for overhead mountings since the worker may be atop a stepladder. Visible indication of operating cam position also aids in ease of adjustment. Adjustment screw is spring loaded so that it is in a nonmesh position at all times, except during adjustment. This greatly reduces wear and possibility of damage to operating cams.

Available in nine different gear ratios, from 20:1 to 1280:1, this switch can be obtained with up to four precision snap-acting switches—each able to control a separate function, or all able to act simultaneously. NEMA Type 1, 4, and 7 enclosed forms are available for adapting the switch to specific environmental conditions.

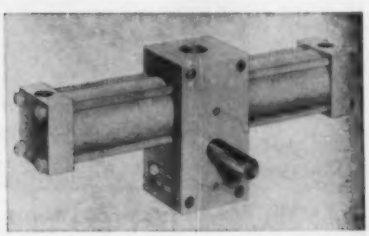
Circle 427 on Reply Card



Flow Ratio Computer

Available in ratings of 3 to 5 psig, VRC ratio computer provides direct measurement of flow ratios and can be applied to new or existing systems. It will sound an alarm or limit the flow of one liquid when ratios exceed a critical point. Output of the instrument can be recorded for historical purposes or for reference in developing related liquid ratios for other processes. Output can also be used as the measured variable input to a VC controller. Computer operates at an accuracy of 1 per cent and provides accurate ratio measurements throughout full range of a system rather than at a single optimum point. **Republic Flow Meters Co., Subsidiary, Rockwell Mfg. Co.**, 2240 Diversey Parkway, Chicago 47, Ill.

Circle 428 on Reply Card

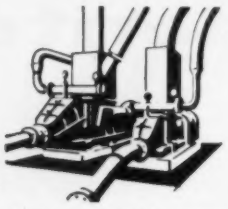


Rotary Actuator

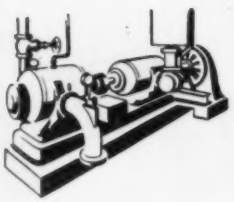
Functions of this reversible rotary actuator include power steering, gate operation, indexing, tool positioning, and azimuth control. It is driven by air or hydraulic fluid pressure. Two opposing pistons move a gear rack over a pinion on a drive shaft for any desired rotation up to

FULLER EQUIPMENT

for the process industries

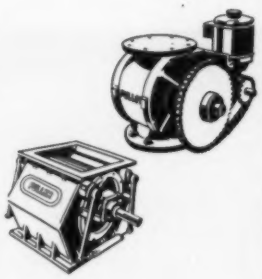


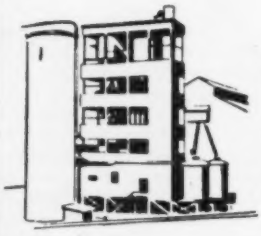
Pneumatic Materials Handling Systems. Widely specified throughout the process industries, Fuller's range of equipment offers best single source for solving problems in moving dry bulk materials pneumatically. Fuller-Kinyon Pumping Systems, Airveyor® Pressure and Vacuum Conveying Systems, and F-H Airslide® Fluidizing Conveyors are completely sealed to prevent both contamination of the product and any leakage of dust, etc., into the surrounding area. They are used to move dry, granular and pulverized materials to and from cars, ships, trailers, storage and processing points.



Fuller Rotary Compressors and Vacuum Pumps are vibration-free, can be installed anywhere, even on balconies. Fewer moving parts mean minimum maintenance. Compressors and Vacuum Pumps handle air and gases from 30 to 3300 cfm at pressures to 125 lb. gage. Vacuums to 29.95 in. (referred to 30-in. barometer).

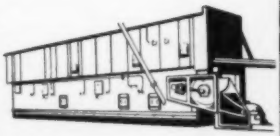
Fuller Vane-type and Roll Feeders . . . for volumetrically controlled feeding of a wide range of dry pulverized or granular materials. Also Fuller Rotary Valves . . . used under silo deck slabs and bins to permit the free flow of pulverized materials which tend to arch, such as lime and cement raw materials.





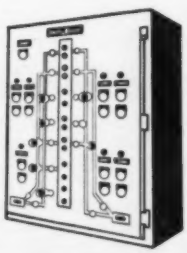
Fuller Preheaters, Humboldt Suspension Type . . . for preheating dry, pulverized Portland cement raw materials with rotary kiln waste gases.

Fuller Horizontal and Inclined Grate Coolers are compact, easily installed for fast, efficient cooling of materials such as nodulized phosphate rock, pebble lime, ores, dolomite, iron nodules and Portland cement clinker from 2800°F. or higher to any desired point within a reasonable range of atmospheric temperature.



Fuller-Material-Level Indicators signal audibly and visibly when materials reach a predetermined high or low level. Controls conveyor motors, valve circuits, etc.

Fuller Control Panels permit automatic, remote, one-man control of multiple operations. Easily-read panel permits visualizing flow of material to storage or from process bins.



Fuller equipment is designed to help give you maximum efficiency at minimum cost. Send today for more detailed literature.

1356
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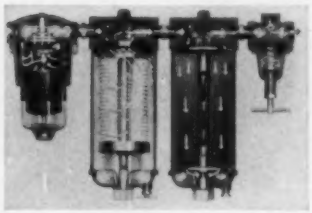
360 degrees. Rotation of the shaft may be stopped and reversed at any part of the cycle. Three models are offered, developing 50 to 314 pound-inches of torque with 100 psi pressure. The drive shaft is keyed for use with stock worm or spur gears or special cam or lever attachments. **Mo-Bar Hydraulics Co.**, Crystal Lake, Ill.

Circle 429 on Reply Card

Data Scanning Relay

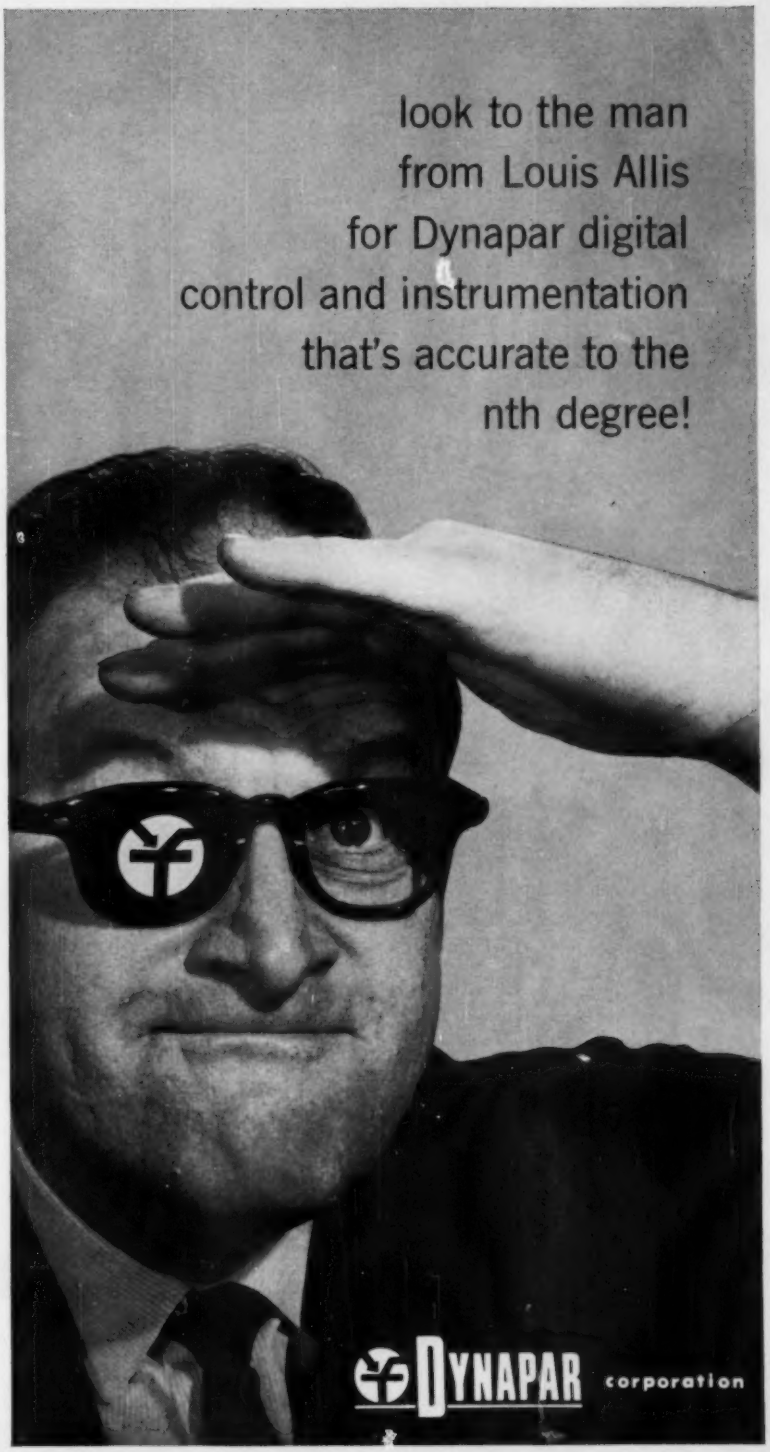
Relay features an electromechanical relay coil. It utilizes two replaceable sealed cartridges containing the armature and fixed contacts. Magnetic coupling to the relay coil permits a DPDT configuration ideally suited to low-level data sampling. The inherent simplicity, absence of wiping contacts, and rugged construction contribute to a trouble-free service life exceeding 200 million operations. This relay is ideally suited to the rapid sampling of multiple low level transducers such as strain gages and thermocouples. In most applications the switching unit introduces less than 10 microvolts of extraneous signal into the circuit being commutated regardless of impedance level. Dwell periods as brief as 250 microseconds and dynamic resistances of less than 1.0 ohm enable fast, accurate multiplexing of low level transducers. The relay is a high performance device designed for multiplexing microvolt signals at the rate of several hundred samples per second. **Magnavox Research Laboratories**, 2829 Maricopa St., Torrance, Calif.

Circle 430 on Reply Card

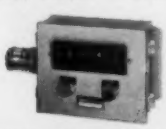


Air Dehydrator Package

Compressed air dehydrator package for drying air and ridding it of oil and dirt contaminants can lower the dew point of air to minus 100F and can remove oil to 2 PPM. It is available as shown or can be obtained with any one of the units omitted or other special units added. The complete system or any part of it is useful for paint-spraying operations, pneumatic instruments and air gages, in glass blowing operations, and for cleaning out pipelines for military installations where nitrogen is commonly used. System does not require draining since the first stage has a moisture separator with a built-in



Dynapar is the electronic subsidiary of The Louis Allis Co., Milwaukee 1, Wis. We make a full line of transistorized digital counting, measuring, and control devices. Information on any of these products can be obtained from your local Louis Allis District Office — which is listed in The Yellow Pages under "Electric Motors."


Draw Indicators

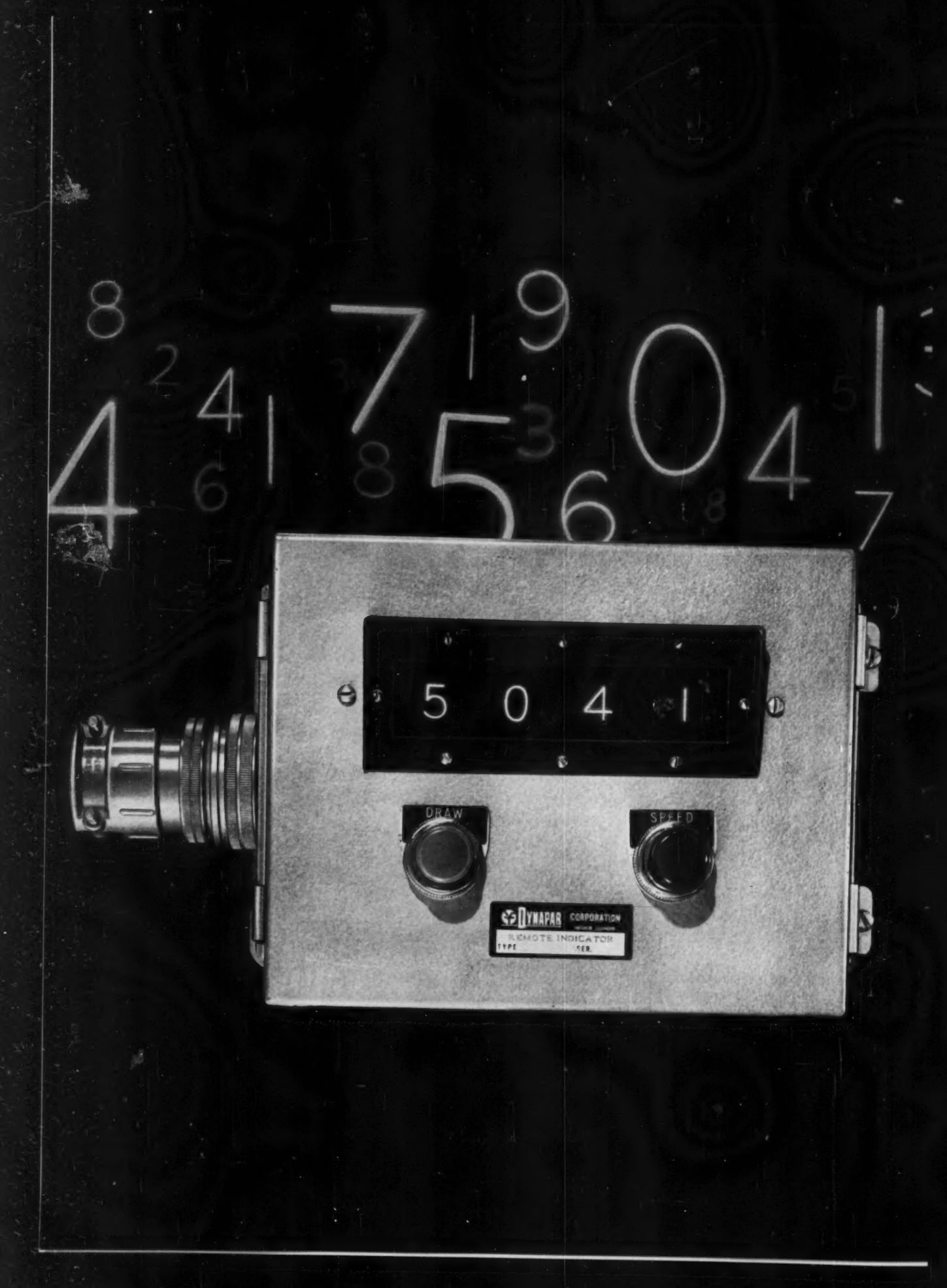
Process Controllers

Rotopulsers

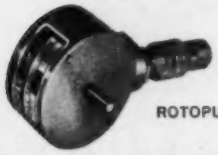
DD-222

DYNAPAR CORPORATION, 7312 N. RIDGEWAY AVENUE, SKOKIE, ILLINOIS

Circle 691 on Reply Card


5041
DRAW
SPEED
DYNAPAR CORPORATION
REMOTE INDICATOR
TYPE
SER.

PROCESS CONTROLLER



ROTOPULSER

New product news from Louis Allis

NOW... Louis Allis offers DYNAPAR* Digital Control Systems!

Louis Allis can supply accurate digital controls designed to industrial standards for a wide variety of continuous process lines

For any production process, Louis Allis can furnish not only motors, drives, and controls, but also digital monitoring equipment to provide visual readout and process control signals.

The answer is DYNAPAR* Digital Control — a highly accurate digital logic system that can count, measure, totalize, indicate, time, or control depending on the requirements of the application. Digital systems are ideally suited for high speed counting — accurate measurement of speed and draw — automatic cutting-to-length — automatic positioning — and many other applications.

Dynapar's digital devices utilize precise pulses, and eliminate the drift inaccuracy inherent in magnitude-measuring analog systems. There's no need for constant calibration or adjustment. Pulses are reliably provided by rugged ROTO-PULSERS, highly stable sensing and pulse generating devices — visual indication is obtained by easily-read luminous direct numerical readouts. Control functions are accomplished by a variety of special devices tailored to specific operations. All DYNAPAR equipment features the most modern solid-state transistorized circuitry to provide long-life operation without maintenance.

Investigate to see how Louis Allis-Dynapar equipment can increase production and cut waste by automating *your* process. Call your local Louis Allis District Office, or write to The Louis Allis Co., 463 E. Stewart St., Milwaukee 1, Wis.

*Dynapar Corporation is the electronic subsidiary of The Louis Allis Co.

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

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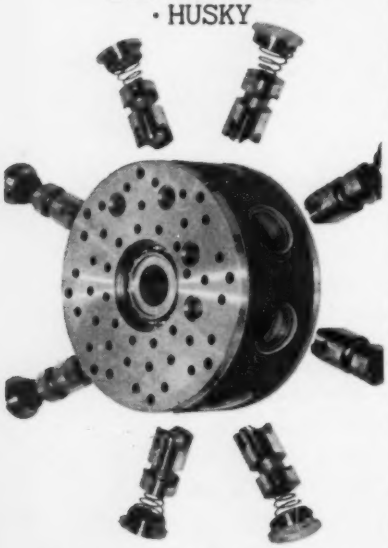
· HIGH TORQUE · EFFICIENT
· LOW PRESSURE
· HUSKY



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Cimtrol Division
The Cincinnati Milling Machine Co.
Cincinnati 9, Ohio

CIMTROL

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automatic sump drain mechanism. No electrical or water connections are needed. The entire desiccant is visible in the dehydrator through its transparent sheet. **Wilkerson Corp.**, 1552 W. Mansfield, Englewood, Colo.

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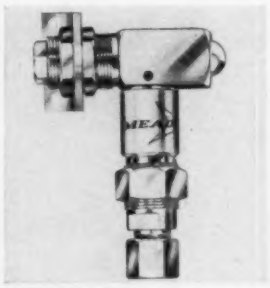


Limit Valve

Designated Interlock limit valve No. 408, this pneumatic component bleeds only enough air to shift a master valve before closing itself automatically. It actuates differential pressure master valves of the pilot bleed type. Bleed duration may be changed to compensate for circuit requirements that vary with distance from master valve, master valve capacity, and speed of actuation. Flow direction may be changed by another limit valve even while the Interlock valve remains depressed. Consequently, this unit finds applications in circuits that call for one limit valve plunger to stay depressed throughout a series of operating cycles. **Mead Specialties Co.**, Chicago, Ill.

Circle 432 on Reply Card

Pushbutton Switch

Equipped with a sliding latch for padlocking, electrical pushbutton switch is available in two styles and is designed for low-cost lockout protection on a wide range of industrial applications such as conveyor systems, automation lines, complex machine tools, etc. It enables maintenance personnel to stop any one motor of a complex system. Then by padlocking the latch, they can safely repair the equipment regardless of other nearby machines. Model 3829 has a single plunger and is normally furnished with one set of momentary transfer contacts (other contact arrangements are also available). Model 3827 has two plungers in a single unit. **Mackworth G. Rees Inc., Div., Avis Industrial Corp.**, 1573 E. Forest, Detroit 7, Mich.

Circle 433 on Reply Card

Magnetic Brake

Eight-inch dc magnetic brake is built to AISE-NEMA standards for 600 Series mill motors. Nut-cracker principle of operation assures that equal pressure is applied against the wheel by both shoes, which are self-aligning and symmetrical. The shoes fit either side, either end up. Magnet coil can be changed on the job without dismantling the brake. A single adjustment compensates for lining wear and magnet gap and is easily accessible from the top. A built-in indicator shows when adjustment is needed. Also, to simplify maintenance an indicator is provided for torque setting. **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio.

Circle 434 on Reply Card

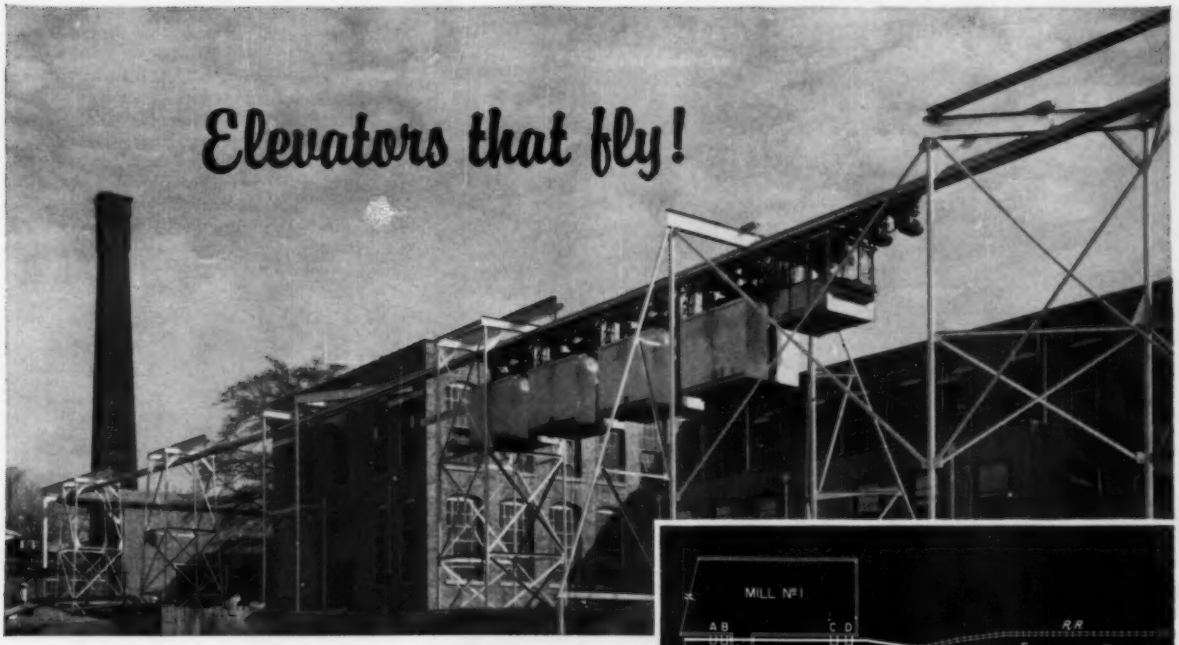
Explosion-Proof Pump

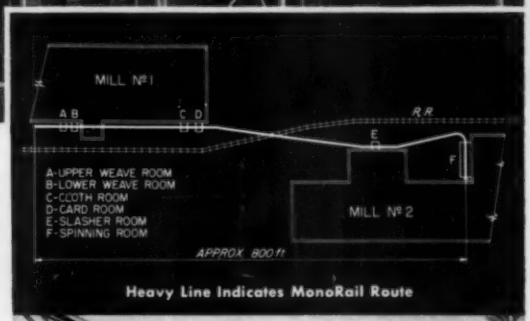
Pump has been developed for use in explosive atmospheres. It was designed for handling of corrosive, sterile, or abrasive liquids or gases. There is no contact between the moving parts and the material being pumped. Available with ¼-hp explosion-proof motor, explosion-proof switch, flexible conduit, and explosion-proof plug, the pump is suitable for pumping flammable liquids and gases. It is available in two sizes—54 and 185 gallons per hour. **Randolph Co.**, 1018 Rosine St., Houston 19, Tex.

Circle 435 on Reply Card

Displacement Transducer

Utilizing an Atcotran linear variable differential transformer with a linear range displacement of ±0.500 inch, transducer can be used for mechanical applications subject to severe operating conditions.





Heavy Line Indicates MonoRail Route

AMERICAN MONORAIL

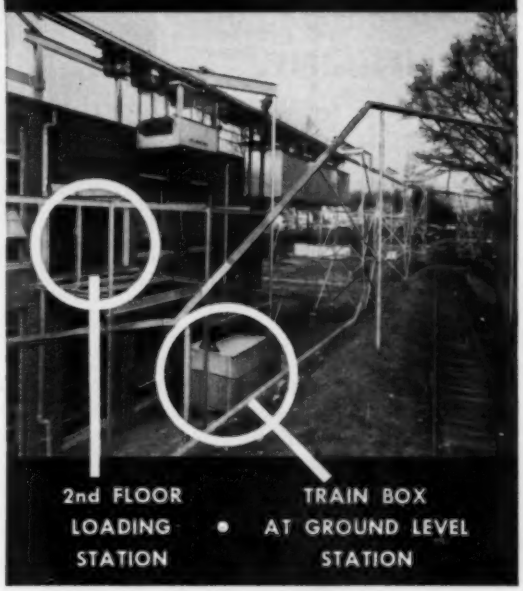
transports cars between 2 mills-

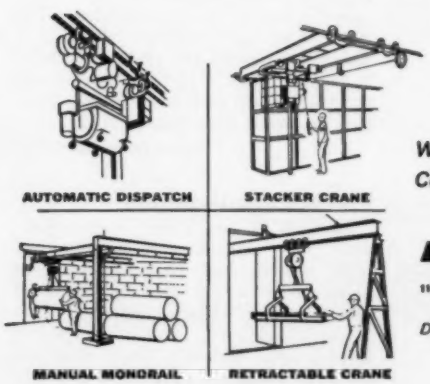
stops at ground and upper level stations.

The equivalent of several elevator loads of material can be transported from building to building and from floor to floor by this modern materials handling system. Erected entirely out of doors, the MonoRail operates overhead, safely above railroad and all other traffic, and takes up no space at all inside the mills.

Loads transported consist of warp beams, boxes of filling quills, roving, trucks of drawing sliver and cloth. Approximately 132,000 lbs. from stations at each mill are transported during an 8-hour shift.

All operations can be controlled from the cab which is equipped with heaters, electric fans, windshield wipers, a gong and spotlights for night operation.





Write for Bulletin C-2.
Contains 56 pages, 99 photos.

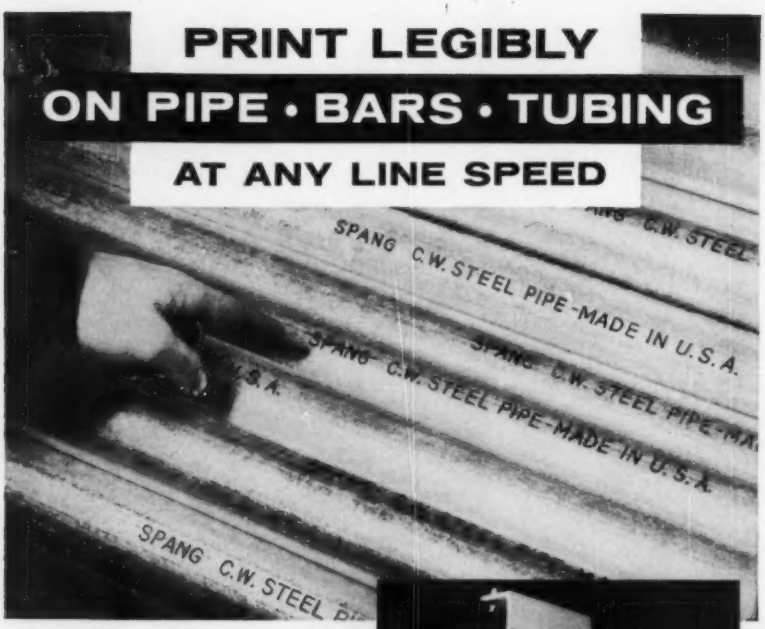
ENGINEERED MATERIALS HANDLING

1144 EAST 200th STREET CLEVELAND 17, OHIO

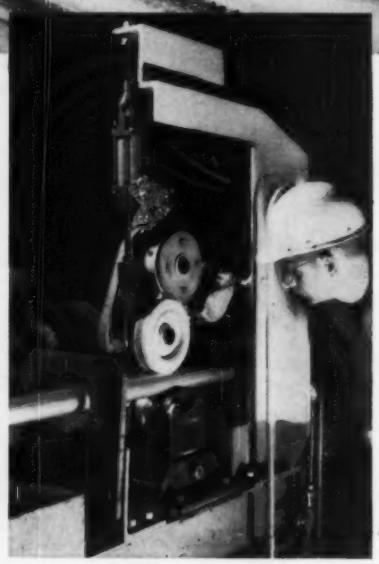
AMERICAN MONORAIL

DIVISIONS: Conveyor Division, Tipp City, Ohio — Canadian Monorail Co., Ltd., Brampton, Ont.

© A.M. Co. 1961



with
MATTHEWS
ROTARY
IN-LINE
OFFSET
PRINTERS



Designed for installation over production lines, Matthews Rotary In-Line Offset Printers are sturdy built for industrial use, and may be friction or power driven to suit your application.

Offset printing produces outstanding marking and permits the use of large characters on smaller tube diameters – with no distortion. Prints on round products of any diameter – flats and most shapes.

Write for Bulletin A-477.

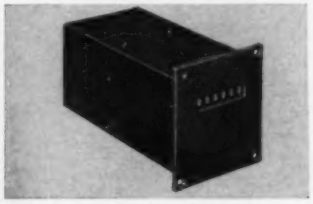
MATTHEWS MARKING PRODUCTS

JAS. H. MATTHEWS & CO.
3945 Forbes Ave. • Pittsburgh 13, Pa.

Circle 695 on Reply Card

Features include built-in mechanical zero adjust, sealed but accessible range adjust, and dual stainless steel guide shafts—each ⅜-inch in diameter. Uses include: Checking dimensions of work output on centerless grinding machines; thickness gaging of fiberboard, plaster board, billets and sheets; wobble detection; out-of-round measurements; and machine tool positioning applications. **Automatic Timing & Controls Inc.**, King of Prussia, Pa.

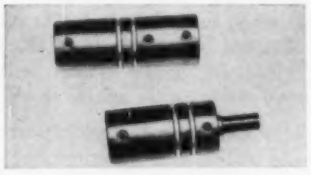
Circle 436 on Reply Card



Electronic Impulse Counter

Featuring a new type electromagnetic stepping motor, unit counts 100 impulses per second. It can be used to measure time and distance by direct measurement in decimals with no conversion needed. Particularly adaptable for data processing and automation equipment, counter has a life of 500 million counts. It is available with either 5 or 6 figure drums and can be operated with an electromagnetic or mechanical zero reset. Specially designed stepping motor consists of a five-pole rotor and two electromagnets. **Ringsdorff Carbon Corp.**, Box 22, E. McKeesport, Pa.

Circle 437 on Reply Card



Miniature Slip Clutches

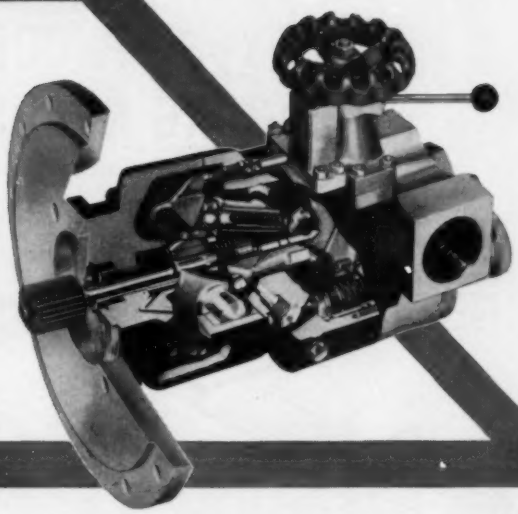
Adjustable miniature slip clutches have application as overload couplings or where a constant torque drive is required. A typical application is as drive coupling in a servo system. A locking-type set screw adjusts torque transmission through a range of from 0 to 4 pound-inches. Two clutch types are available. Model K is designed to couple two shafts. Model M is supplied with a ¼-inch bore on one end and ¼-inch shaft on the other. **Precision Specialties Inc.**, Pitman, N. J.

Circle 438 on Reply Card

Preset Potentiometers

Designed for heavy duty control functions, preset potentiometers shown are oil tight, accommodate single or multigang potentiometers and molded terminal strips, and fit into NEMA, JIC, or UL enclosures. Model SC-CP, left, has a quick-setting knurled knob and is a single turn unit accommodating 1, 2, 3, or 4 center-tapped

Nine piston, variable volume, pressure compensated type IA-38-9 pump, designed for use on Ground Support Equipment.



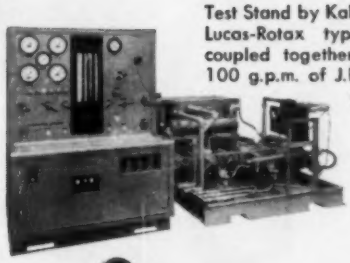
VERSATILITY-PROVEN *lightweight hydraulic* PUMPS AND MOTORS

Well known equipment manufacturers are specifying Lucas-Rotax hydraulic pumps and motors because they offer

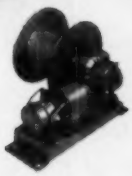
- size and weight advantages in the 4 to 104 g.p.m. flow range
- pressures up to 5000 p.s.i.
- low noise level
- other attractive design features

Lucas-Rotax provides full engineering, sales and service throughout North America.

Your hydraulic requirements will be met by contacting Lucas-Rotax Limited, Toronto.



Test Stand by Kahn Company. Three Lucas-Rotax type IP-525 pumps coupled together provide flow of 100 g.p.m. of J.P.4 fuel for testing aircraft equipment.



Marine winches by Timberland-Ellicott are powered by Lucas-Rotax pumps and motors.

Two IA-38 pumps are incorporated in the portable Test Stand by Consolidated Diesel for use in checking out hydraulic system components on fighter aircraft at 5,000 p.s.i.

products of creative engineering by

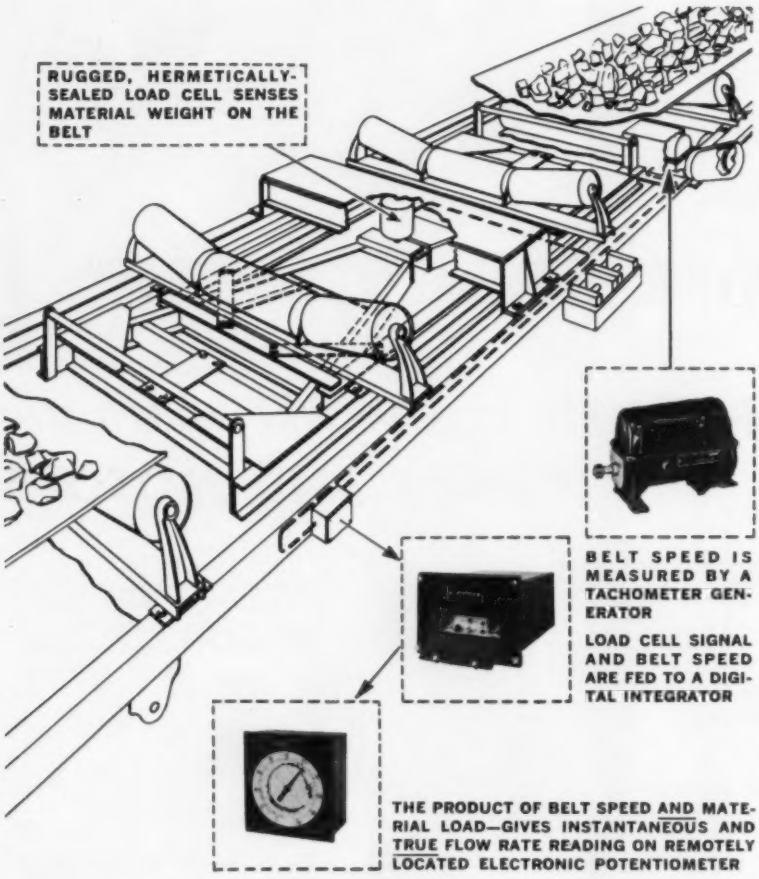
LUCAS-ROTAX LIMITED

2200 EGLINTON AVE. EAST, TORONTO, ONTARIO.
POSTAL ADDRESS: BOX 115, STATION H, TORONTO 13.

6102

Circle 696 on Reply Card

A SIMPLE, COMPACT SYSTEM CAN MEET YOUR PROCESS WEIGHING NEEDS!


RUGGED, HERMETICALLY-SEALED LOAD CELL SENSES MATERIAL WEIGHT ON THE BELT
BELT SPEED IS MEASURED BY A TACHOMETER GENERATOR
LOAD CELL SIGNAL AND BELT SPEED ARE FED TO A DIGITAL INTEGRATOR
THE PRODUCT OF BELT SPEED AND MATERIAL LOAD—GIVES INSTANTANEOUS AND TRUE FLOW RATE READING ON REMOTELY LOCATED ELECTRONIC POTENTIOMETER

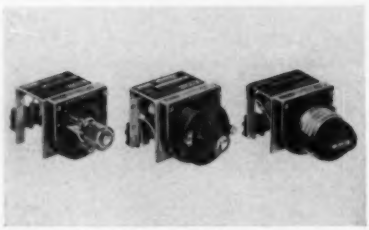
Adaptations of this basic system assure accurate, automatic, continuous weighing and control of the widest range of solids for feeding at preset rates... batching to deliver set quantities... blending several materials (including fluids) in set ratios. Give us your process requirements; we engineer the automatic dependable weighing and control system to match!

WRITE FOR BULLETINS

Bulletins 60 & 70 describe W&C/T-W Conveyor Scale Systems
Bulletin 14 describes W&C/T-W Automatic Batch Weighing Systems

Weighing & Controls, Inc. / TRANS-WEIGH COMPANY
Subsidiaries of CompuDyne Corporation
HENDERSON ROAD • KING OF PRUSSIA, PENNSYLVANIA

Circle 697 on Reply Card



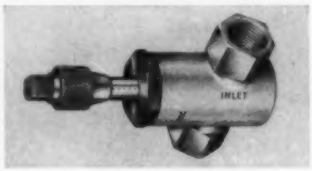
and wire wound potentiometers. Two adjustable stops limit swing of indicator pointer or can be used to lock knob in a preset position. Model SC-CM, center, is a ten turn preset unit and has a dial graduated from 0 to 99 for a single revolution and a 0 to 9 digit counter for each complete revolution. A knob locks dial in desired position. Model SC-CM, right, is a direct reading, ten turn preset unit with a three digit counter. Numerals are large, and window permits wide angle viewing. A finger-tip knob lock is provided. **Servocontrol, Div. of Oilgear Co.,** 1560 W. Pierce St., Milwaukee 4, Wis.

Circle 439 on Reply Card

Photoelectric Relay

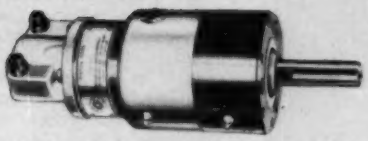
Designed for rugged use, Type R5-FD2 photoelectric relay can be used for such applications as counting people, shipments, and objects at speeds to 1200 per minute; signalling approach, departure, and movement; alarming for trespass, entrance, darkness, or light; and controlling operations, movements, conveyors, and machines. Having transistors but no vacuum tubes, the relay requires no warm-up time and has no anticipated maintenance requirements. It is water-proof, dust-proof, and vibration-proof in a cast iron housing. Device is capable of operating in any position. **Electric Eye Enterprises,** 15540 W. Dixie Highway, North Miami Beach, Fla.

Circle 440 on Reply Card

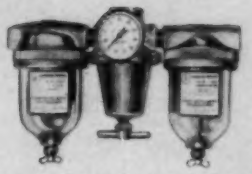


Liquid Flow Regulator

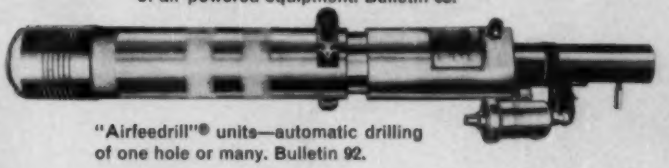
Constructed of stainless steel and anodized aluminum, adjustable restrictor-type flow regulator may be used in any low-flow circuit that handles fluids compatible with these materials. It features a linear reference scale permanently stamped onto the stationary sleeve for adjusting the valve flow. Valve is de-



Air Motors—provide rotary or linear motion. Bulletin 70.

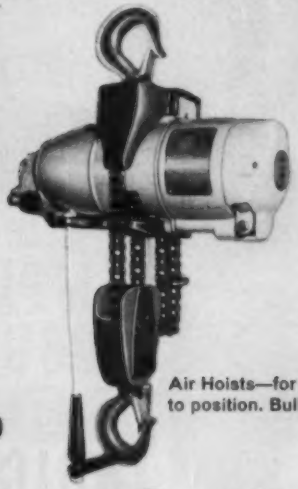


Filter-Regulator-Lubricator—for protection of air-powered equipment. Bulletin 65.

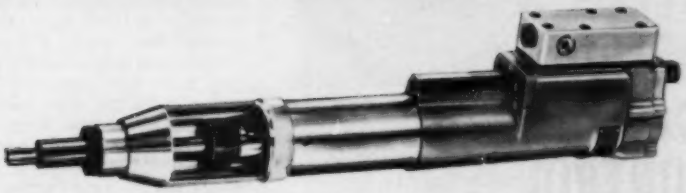


"Airfeedrill"® units—automatic drilling of one hole or many. Bulletin 92.

BUILDING BLOCKS FOR AUTOMATION

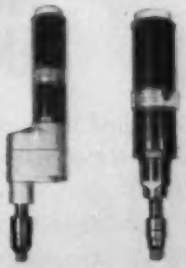


Air Hoists—for lifting to position. Bulletin 86.



"Tru-Thread"® tappers—for highest quality, precision-tapped holes. Bulletin 93.

"Tru-Feed"® drills—automatic, precision drilling in hardest metals. Bulletin 96.



Center or offset spindles—for automatic screw driving or nut setting. Bulletin 16.

Complete line of air-powered components from Gardner-Denver

In planning your automatic production equipment, look to Gardner-Denver for basic building blocks—from power to poppet valves.

These versatile components can be applied all along the line—whatever your requirements. And they can be used over and over in countless situations. There are thousands of combinations of speeds, feeds, sizes, power ranges and tool types.

Before you automate, make a date—with your Gardner-Denver air tool specialist.

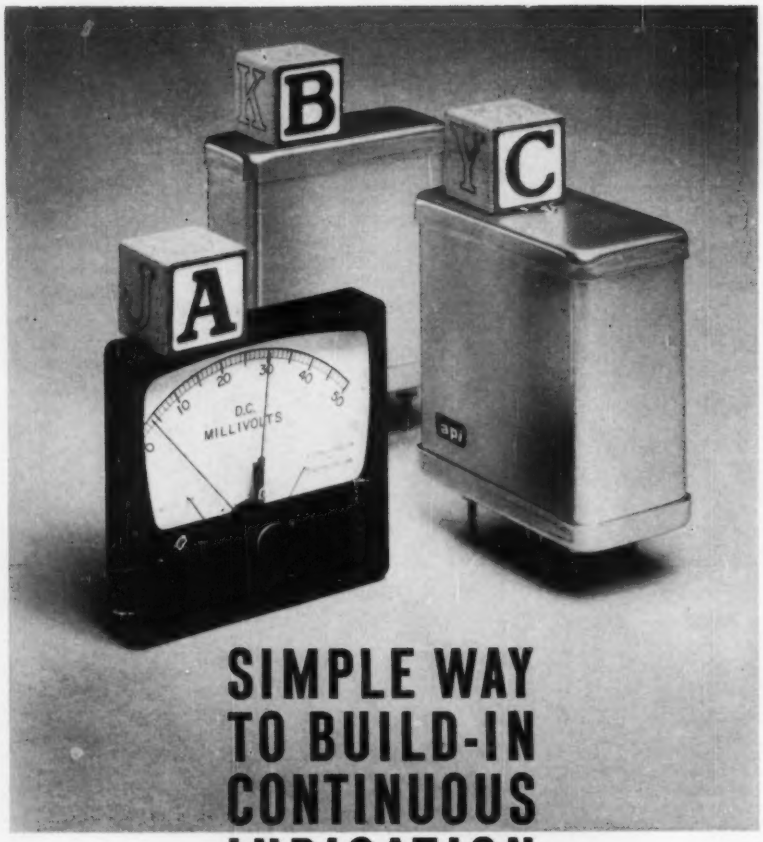
EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Ill.—Offices in principal U.S., Canadian and Mexican cities
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

International: Gardner-Denver International Division, 233 Broadway, New York 7, N.Y.
Offices: Buenos Aires, Argentina; Artarmon, N.S.W. Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal

Circle 698 on Reply Card



SIMPLE WAY TO BUILD-IN CONTINUOUS INDICATION AND CONTROL

It takes just three components to do the job. A Continuous Reading Meter-Relay (CRMR); a power supply; a load relay. Put them together and you have a complete control "system." With it you can add continuous indication and automatic on-off control to any equipment package. That's right—any equipment package. The CRMR will monitor and control any variable transduceable to current or voltage values—even at low, unamplified microamp or millivolt levels. • For the work it does, a CRMR control requires remarkably little space. The meter-relay itself (there are several case styles) requires only a meter-sized panel space. The power supply and load relay are plug-in units; you can mount them on one of our racks or directly on the equipment chassis. • If you are presently working on equipment that could use (or be improved by) continuous indication combined with discrete set-point control, you'd do well to have a look at our Bulletin No. 5. It will give you applicational information, detailed specs, and prices.

api **ASSEMBLY PRODUCTS INC.**
Chesterland 27, Ohio

SA 2459

Circle 699 on Reply Card

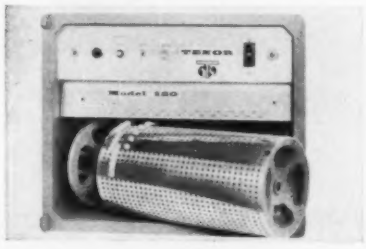
signed for 10 to 100 psi hydraulic circuits requiring constant and accurate regulation of low flow rates. It permits precise flow selection from 0.3 to 1.5 gpm by turning knurled handknob to the desired point on the linear scale and locking it in position. The adjusting screw requires 20 turns to go from minimum to maximum setting, allowing fine adjustment of flow. Accuracy of the regulated flow is then held within ±2 per cent of the flow setting, regardless of variations in system pressure. **Fluid Regulators Corp.**, 313 Gillette St., Painesville, Ohio.

Circle 441 on Reply Card

Photoconductive Cells

Line of photoconductive cells is hermetically sealed and uses cadmium sulfide as the photoconductive material. They are available in four basic sizes: A Compactron type (rear); a 9-pin type in a conventional tube envelope (T-6¼ miniature bulk size) (rear); a medium size and a miniature type, each with flying leads. Compactron Type Z-2946 and Type 7427 are all glass while the medium size cell Z-2963 and the miniature Z-2755-1 are of metal-to-glass construction. All the cells operate over a range of 1400 angstrom units with the wavelength of maximum response at 5500 angstroms. **General Electric Co.**, Schenectady 5, N. Y.

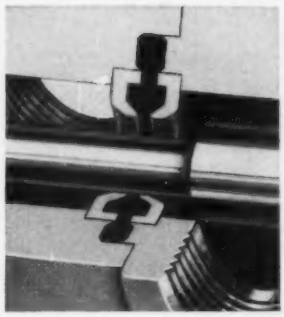
Circle 442 on Reply Card



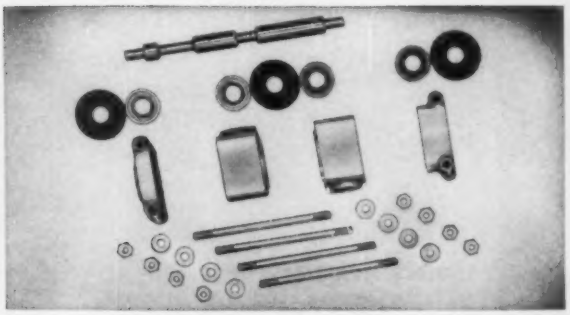
Program Controller

Purpose of device is to automatically sequence processes or operations. It consists of a drum mounted adjacent to a row of switches. The drum is stepped through 360 degrees in a total of 60 steps, stopping at each step and holding until signaled to step again. Pins located along the length of the drum depress and activate the switches located adjacent to the drum. Thus, a series of functions can be made to take place simultaneously. Advance from one combination of functions to another combination of functions is made at a given signal. Signal

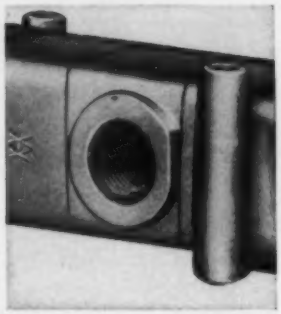
Do the air valves you buy include these quality features?



SEAL—Exclusive, triple-supported seals permit interference fit of spool for extra-tight closure with minimum wear. Usual damage to conventional "O" rings by moving spool is eliminated.



SIMPLICITY—Uncomplicated parts mean long life and easy servicing. Common parts are used extensively to simplify stocking or repair.



FLEXIBILITY—Modular Construction. Operators, mounting holes and ports may be independently rotated in 90° steps. Operator may be on either or both ends.

This high-quality "D" Pilotair® Valve is available in thousands of combinations. Tailored valves at standard model prices. Nine basic valves may have one or two of eight operators. Many types of spring return or holding functions.

if not, the chances are your maintenance costs are higher than necessary. For more information about quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A4-75.01.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

SANDVIK
STEEL BELT
CONVEYOR

Automates Heavy, Abrasive, Oily Load At Chrysler Corp.

At Chrysler Corporation's Mound Road engine plant this 24" x 120' Sandvik steel belt unit feeds or backlogs up to 2,400 rocker arms per hour in an automatic machining line.

Normal load is around 60 lbs. per foot but can run up to double that under back-up conditions. **The solid steel belt withstands this weight plus the oil and abrasion involved in carrying, live-backlogging and plowing-off the sharp-cornered rocker arms to each successive machine.**

Your nearest Sandvik office will be glad to furnish further information.

SANDVIK STEEL, INC.
Steel Belt Conveyor Dept.
1702 Nevins Road, Fair Lawn, N. J.

Cleveland, Detroit, Skokie, Ill., Los Angeles. In Canada: Sandvik Canadian Ltd., P.O. Drawer 1335, Sta. O, Montreal 9, P.Q.

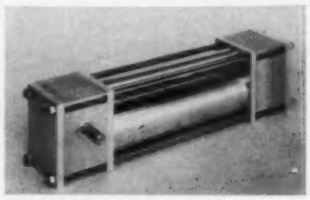
SANDVIK STEEL BELT CONVEYORS

SB-538

Circle 701 on Reply Card

can be from any source or instrument which will supply an electrical impulse when a change in function is desired. Programs are easily changed in the field by relocating the pins on the drum or by using pre-programmed interchangeable drums. The programmed drums become memory units so that any process or control problem can be stored and used at a later date. **Tenor Co., Div., Milwaukee Chaplet & Mfg. Co. Inc.**, 13460 W. Silver Spring Drive, Butler, Wis.

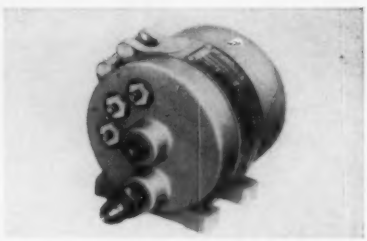
Circle 443 on Reply Card



Rotary Actuator

Rotary actuator called Roto-Cyl is used to convert hydraulic or pneumatic power into uniform rotational motion. The unit is completely sealed and explosion-proof and has no exterior moving parts other than the rotary power output shaft. Within the cylinder a self-centering piston is rigidly coupled to an endless chain that links an idle sprocket in one end of the cylinder with the output shaft drive sprocket in the other end of the cylinder. The actuator is sensitive to minute changes in the flow of actuating fluid and reacts without backlash. Operation is not limited to a single revolution of the output shaft, but can provide as many turns as desired with constant torque. The piston within the cylinder is teflon-sealed and may be used with all hydraulic fluids or air. Actuator is available in sizes ranging from small instrument actuators to heavy industrial power actuators. **Graham Engineering Co.**, 714 Loma Verde Ave., Palo Alto, Calif.

Circle 444 on Reply Card



Pressure Transducer

Incorporating multiple taps or sawtooth outputs with high resolution for aircraft control systems, Model 45176 pressure transducer is available in a wide variety of ranges, including absolute, differential, or gage. It features low friction and repeatability error and low to high impedance outputs. Additional applications include mach computers, ground checkout systems, and process control devices. **Giannini Controls Corp.**, 1600 S. Mountain Ave., Duarte, Calif.

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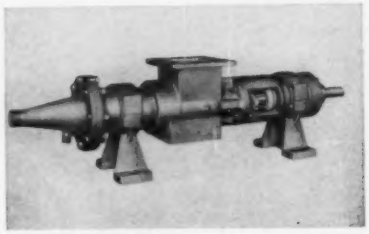

Dry Powder Pump

Function of this pump is to convey dry powders through totally enclosed systems. It utilizes a progressing cavity principle of operation in which cavities are formed between the helical rotor and the double helical stator during rotation and then are moved toward the discharge end. Capable of handling up to 24,000 lb per hour, pump is designed to replace blowers, ducts, and dust collectors. It will function effectively in runs up to 200 ft or longer, and is capable of vertical lifts of more than 75 ft. **Moyno Pump Div., Robbins & Myers Inc.**, Customer Service Dept., Springfield, Ohio.

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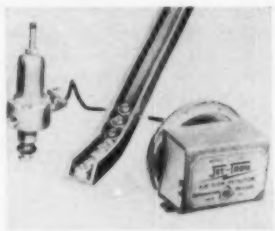

Control Switch

Designated Jet-Tron, this pneumatic control switch is designed to produce an electric signal when an object interrupts the flow of air across an opening. This signal can be used for the control of production equipment. Switch will detect the presence or nonpresence of any solid object without physical contact, regardless of the material. Applications include feeder back pressure control, conveyor control, multiple machine co-ordination, safety switch for automatic equipment, level control, and solenoid operation. **Automation Devices Inc.**, 3125 Brandes St., Erie, Pa.

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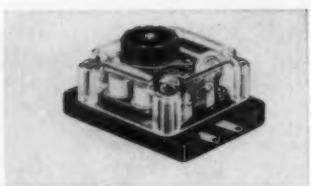

Photocell Amplifier

Direct-current amplifier provides 10 to 1 amplification of low signal inputs from photovoltaic cells. It furnishes a means of measuring extreme low illumination levels in the area below 5 foot-candles. Model 993 is self-contained and features

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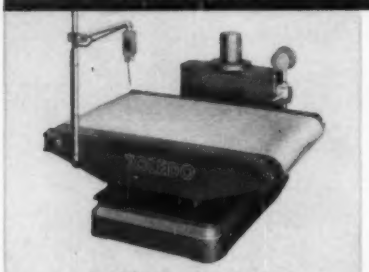

Model 9460 for heavy-duty
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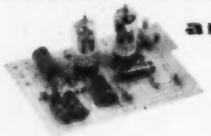
Exclusive TOLEDO phase-sensitive, plug-in amplifiers are totally unaffected by voltage fluctuations . . . assure repeatable accuracy



Now you can have full-time protection against under-weight packages, customer complaints and restrictions on product sales. Put a Toledo 100% In-line Checkweigher on the job. New phase-sensitive amplifiers, an exclusive Toledo development, maintain stable operation independent of plant voltage fluctuations.

Toledo Checkweighers reflect the *most advanced* concepts of scale, material handling, and control engineering. They are compact, free of complex mechanisms and fit easily into most of the widely used conveyor systems. Zone Edge Tolerance is ±1/32 oz. in smaller capacity units to ±¼ oz. in larger models.

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±2 per cent linearity, on-off control for zeroing of a moving coil instrument, pierced input and output terminals, and a quick mounting four-hole base. **Weston Instruments Div., Daystrom Inc.**, 614 Frelinghuysen Ave., Newark 14, N. J.

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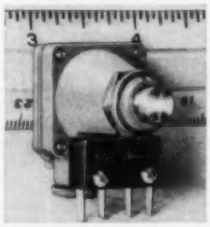

Pneumatic Timer

Miniature pneumatic timer approximating the size of a standard limit switch is 1½ inches square and weighs less than 1 oz. Designed for reliability, it is built for 5 million actuations. Relay is basically a flush mounted component, but comes complete with its own universal bracket for mounting in any position. Time range is adjustable from 0.2 to 15 seconds. Its easily replaced switch is rated at 10 amp. Model 90 will operate efficiently within a repeat accuracy of ±10 per cent in temperatures from 32 to 120 F. It can be used as a combination limit and time delay limit switch. **Hagen Mfg. Co., Subsidiary, E. W. Bliss Co.**, 104 Walnut St., Baraboo, Wis.

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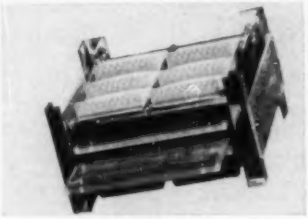
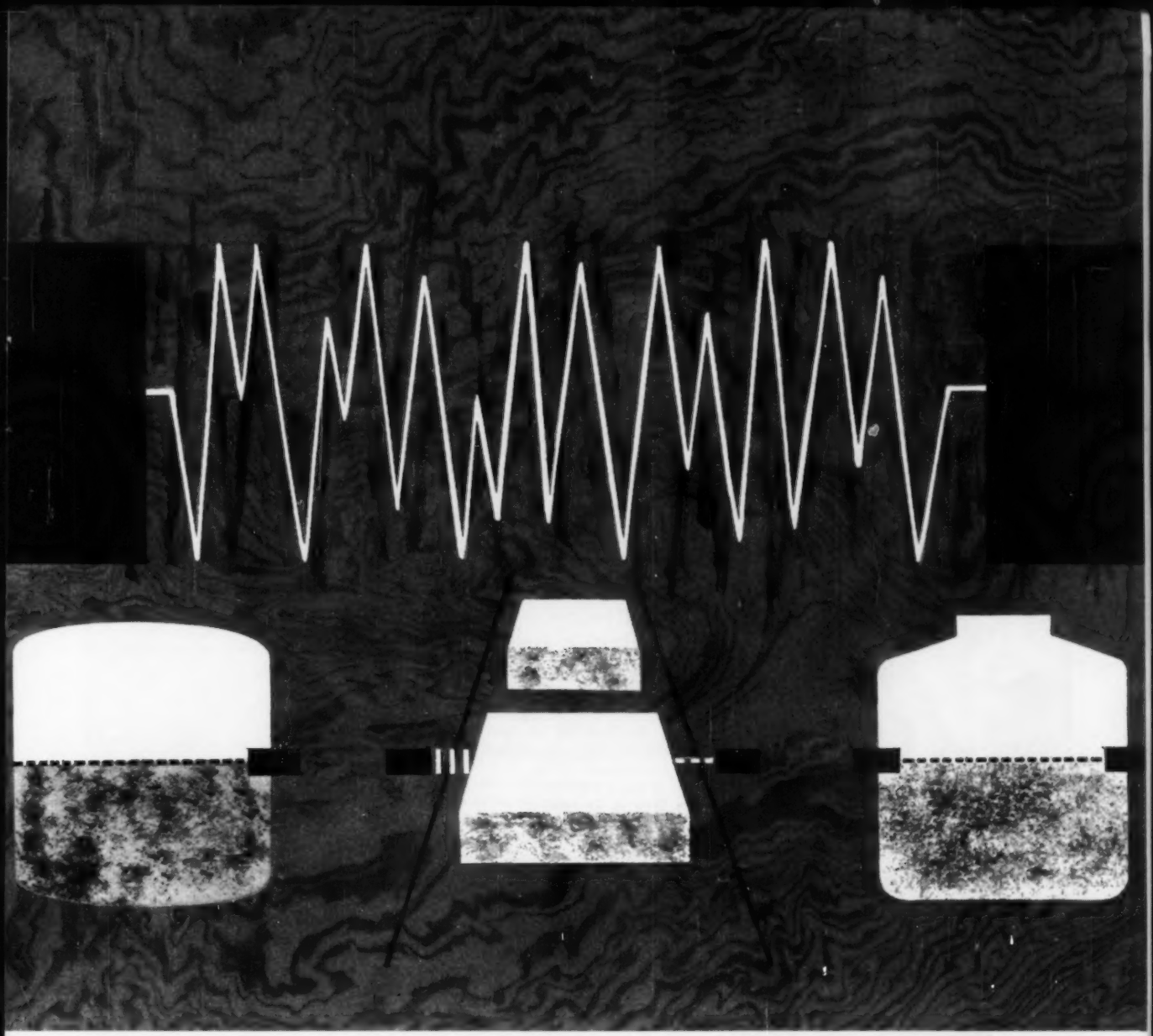


Twistor Memory

Developed for electronic telecommunications systems, twistor memory module employs a new method for using the twistor principle in a semipermanent memory. Semipermanent storage is accomplished by coding a "virtual solenoid" which encloses the twistor elements. By pulsing through the printed-circuit conductor, an eddy current is induced in the copper sheet. The twistor elements then "see" a flux density of sufficient strength to disturb them. But if a hole has previously been punched in the copper sheet at a particular bit location, the flux density will be insufficient to disturb that twistor element. Thus, the semipermanent storage, at any given one or zero bit location, is governed by the presence or absence of a hole in the copper sheet. Coding can be readily changed by sliding the plug-in virtual solenoid from its shelf and replacing it with another. Twistor array is a 16 plane stack; each plane having eight words of 60 bits per word.



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WHY SONAC WILL DO A BETTER JOB THAN YOUR PRESENT AUTOMATED CONTROLS

Sonac's ultrasonic energy "beam" offers you important advantages over present controls. Its transistorized circuit assures low maintenance and long life in even the most severe environments. Sonac sensors are not affected by vibration, dust, smoke, steam, contamination, or too much or too little light. Level controls are not sensitive to viscosity, specific gravity, foam or the electrical characteristics of the material. □ Hermetically sealed sensors operate in temperatures from −325°F to +450°F. They withstand pressures to 2000 psi. What can Sonac do for you? Send for complete descriptive booklet.

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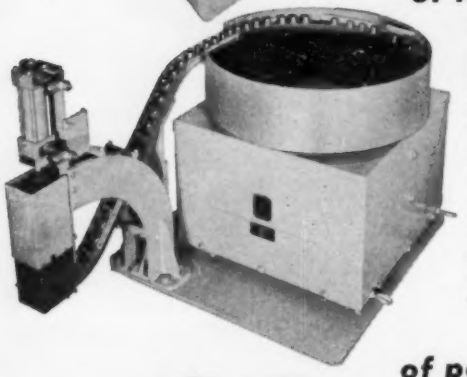
THE CARE AND FEEDING

of parts discharged at high or low heights

DPS ELEVATING FEEDERS elevate, orient and feed parts of almost any size, shape and material to other machinery for processing and assembly. High capacity storage bins are designed to assure a steady flow of parts to elevating mechanism regardless of load level.

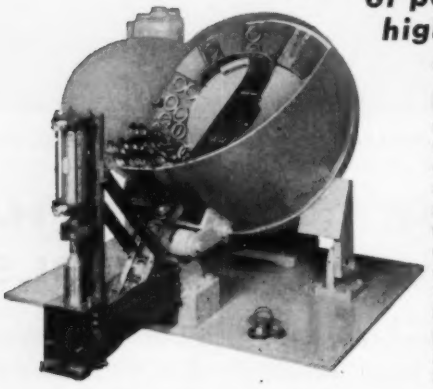
Orientation of parts is accomplished at discharge point of elevator — simplifying external track construction. Feeder can be arranged for right- or left-hand discharge. Return chutes are cushioned.

New Bulletin 2812 has full data on DPS elevating feeders. Write for your copy today.



of fragile or finished parts

DPS VIBRATORY FEEDERS are bowl type units that gently handle parts too light or fragile to be handled in rotary type feeders. Through a simple electromagnetic drive, a vibrating action is transmitted to the bowl causing the parts to move up a circular, inclined track. The oriented parts then enter feed tube or discharge track to machining or assembly areas.



of parts for high-production assembly

DPS ROTARY FEEDERS employ radially slotted or grooved rotating collector rings. Efficient orienting and feeding of parts is achieved through proper design and engineering of baffle plate, selector guard, feed track, and escapement mechanism. Three different designs are available to meet holding, orienting and feeding requirements. Safety clutch prevents damage to motor or gears in the event of parts jamming.

Detroit Power Screwdriver Company offers industry's most complete line of selective feeders . . . ranging in holding area from 80 cu. in. to 20 cu. ft. For complete details, call your DPS representative or write direct. *Ask for free catalogs!* 15,335

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A Subsidiary of Link-Belt Company

Larger storage capacity can be obtained. **Automatic Electric Co., Subsidiary, General Telephone & Electronics Corp.,** Northlake, Ill.

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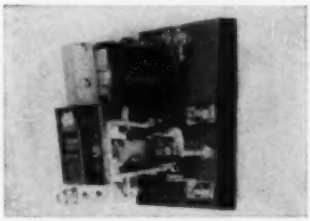

Relays and Contactors

Thirty-amp relays and contactors for noninductive loads can be used in electric heating and lighting. They feature quiet operation, wiping contacts, laminated frame operators, and high contact pressure. Contact rated at 30 amp, 250 v ac, the units may be applied continuously up to their full rating, open or enclosed, with conservative temperature rises. **Automatic Switch Co.,** Sales Promotion Dept., Florham Park, N. J.

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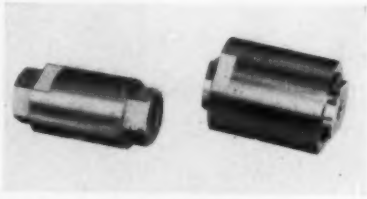

Ball and Shuttle Valves

A Hycar ball or stainless steel shuttle are the only moving parts in line of ball and shuttle valves. Parts shuttle to the left or right, depending on which port is pressurized or has the greatest pressure. Shuttle remains at port until such time as a directional flow change is desired. Operating media may be air, water, or oil. Valves are suitable to many applications, depending upon pressures. **Airmatic Valve Inc.,** 7313 Associate Ave., Cleveland 9, Ohio.

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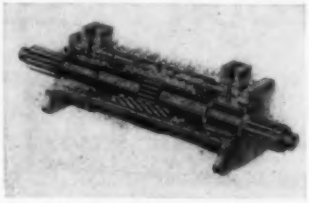

Rotary Torque Actuators

Line of rotary actuators converts hydraulic pressure into powerful, but predictable mechanical torque. They offer angular rotation to 200 degrees with smooth, controlled and cushioned deceleration at the limits of rotation. The torque remains constant regardless of the shaft angular position. The regulators op-

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This man...
is running this locomotive

There is no one in the locomotive. The man in the picture can speed up, slow down, stop or reverse this train, *whether he is riding the locomotive or walking, or standing on the ground.* Both he and the locomotive are equipped with a new Union Switch & Signal remote control system for industrial switching locomotives. Because the operator always can be at the best vantage point, blind operations are eliminated and cars are spotted for loading, unloading or dumping more efficiently. This man can put a car *precisely* where he wants it.

You can minimize the hazards involved as freight moves around your plant with this unique remote control system. If you have a special problem such as moving cars into a thawing pit or under a loading chute, use a centrally located console control unit so one man has complete control over the entire operation.

Look over your in-plant locomotive operation and see if it couldn't be made safer and more efficient if the man running the train could always see what he was doing. Check the coupon for our illustrated Bulletin 187 on how our remote control systems can work for you.

Union Switch & Signal **A**
Division of Westinghouse Air Brake Co.
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erate on pressures up to 5000 psi and require a very low flow of hydraulic fluid. Rotary torque output ranges from 0 to 500,000 lb-inches and is not significantly affected by temperature variations from −65 to 165 F. The actuators will not back off under sustained loads, vibration, or shock. They can be stopped at any angle and remain in place. **Menasco Mfg. Co.**, Sales Dept., Burbank, Calif.

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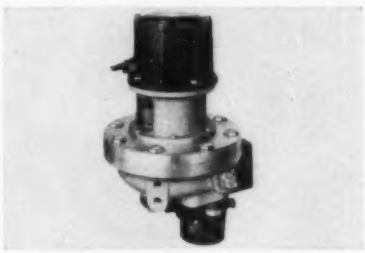

Gas Density Cell

Type 35 gas density cell provides continuous precise measurement of gas density in pounds per cubic foot. Particularly valuable to the gas and chemical industries, it produces a differential pressure directly proportional to density. This measurement, combined with a pressure differential across a primary device, makes it possible to determine mass flow of gas. Instrument measures densities up to 7.8 lb per cu ft. **Foxboro Co.**, Foxboro, Mass.

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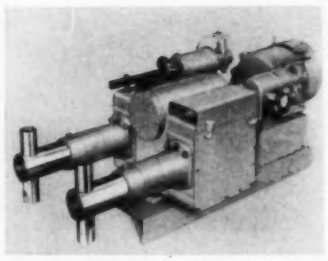


Proportioning Pumps

Line of Strokontrol proportioning pumps has been developed for controlled volume pumping of chemical solutions, slurries, and liquefied gases. A totally enclosed hypocycloidal arrangement of gears is used to provide power transmission and capacity adjustment from 0 to 100 per cent of maximum. Power transmission system eliminates cranks, rocker boxes, and other exposed elements normally needed to convert rotary drive motion to reciprocating pumping action. Pumps are available with maximum capacities from 1.83 to 1472 gph and for pressures to 6500 psi. They are capable of metering accuracy of ±0.5 per cent. **Jaeco Pump Co.**, Villanova, Pa.

Circle 455 on Reply Card

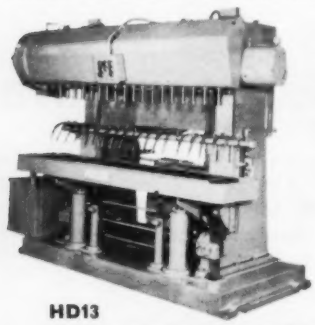
Infrared Detector

Device consists of a low current thermoelectric (Peltier) cooler coupled to a photoconductive indium antimonide element. It can provide high detectivity in the 1 to 6 micron spectral region without complex gas or liquid cooling systems. Except for a small infrared window, all metal construction is used in the compact detector-cooler package. Being completely electronic in operation, unit offers reliable, unattended performance compatible with military and industrial environments and applications. The three-stage cooler, which requires 2½ amp at 2 v, reduces the detector temperature to approximately the dry ice point. Operating temperature of the detector is approximately −78C. **Radiation Electronics Co., Div., Comptometer Corp.**, 5600 Jarvis Ave., Chicago 48, Ill.

Circle 456 on Reply Card

Single Reduction Gearmotor

Designed for direct connection to a driven machine, footless single reduction gearmotor is available with NEMA style C or D brackets in 9 and 10⅞-inch face plate diameters respectively. It is available from 1 to 5 hp, 230 to 780 rpm in drip-proof, totally enclosed, and explosion-proof designs. Other Unimount Syncrogears are available from fractional

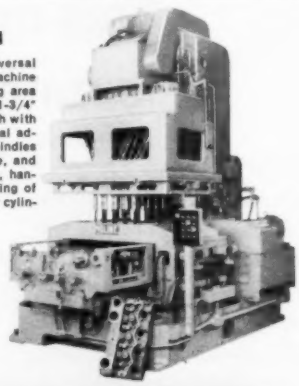


HD13

straight line drilling machine with hydraulic table feed and 18 spindles each having 11/16" diameter drill capacity in mild steel. Spindle center distances are adjustable along the 6-foot machine rail.

MODEL HU111

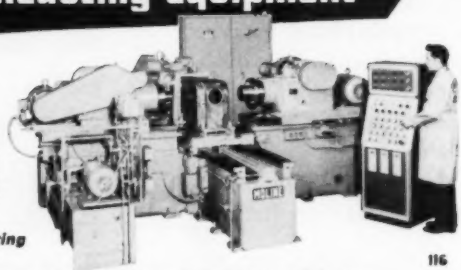
Hydraulic Feed, Universal Joint-Type Drilling Machine with 24" x 50" drilling area and with forty-two 1-3/4" spindle drivers, each with two-speed and neutral adjustment. Thirty-six spindles in slip spindle plate, and power shifting fixture, handle drilling and reaming of three different engine cylinder heads.



MOLINE Cost Reducing Equipment

MODEL MR148

Three-way, three-spindle, horizontal boring machine with selective automatic feed cycle. Handles boring of cylinder and crank bore for 3 sizes of 1-cylinder blocks. Also bores for wet sleeves in 2- and 3-cylinder blocks.



60 years of Machine Tool Engineering Experience is at your service for

116

- Multi-Spindle Boring • Single and Multi-Spindle Honing
- Straight Line Multi-Drilling • Adjustable Spindle Drilling
- Special Multiple Operation Machine Tools

Write for Details

MOLINE TOOL COMPANY
100 20TH STREET • MOLINE, ILLINOIS

REPRESENTATIVES IN PRINCIPAL CITIES

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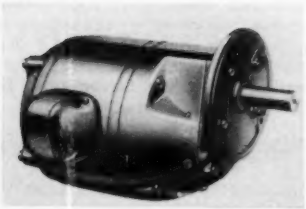
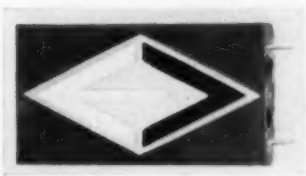


to 75 hp, in many different speeds, configurations, and mounting positions. Features of motor include asbestos protected windings, normalized castings, and quiet operation. **U. S. Electrical Motors Inc.**, Box 2058 Terminal Annex, Los Angeles 54, Calif.

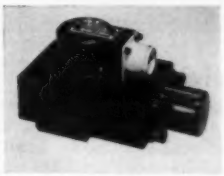
Circle 457 on Reply Card



Electronic Counter

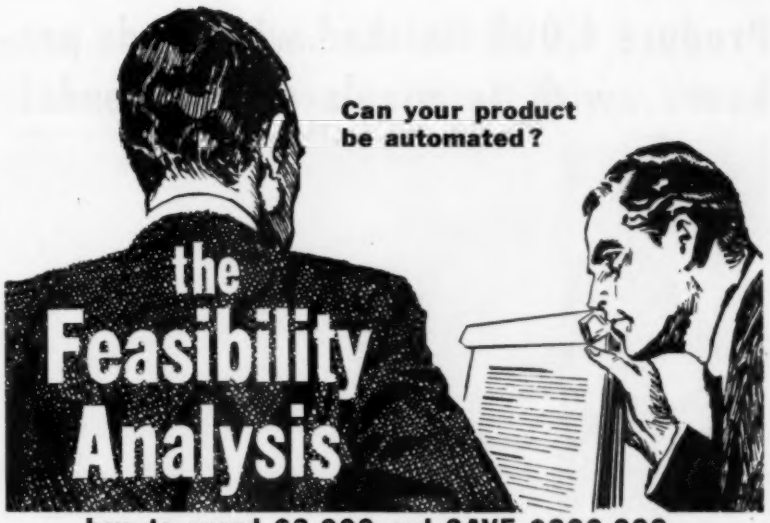
Utilizing the variable dividing principle, electronic counter is capable of counting a wide range of items. Potential uses are in process control, tachometer systems, traffic and event counting. The 8001 Universal counter provides a presettable, count-controlled output impulse on each 10th input pulse. The count can be changed, as desired to a 9, 8, 7, etc., down to a 2 or 1 count. Modular units can be coupled directly in tandem for number or word structure. In tandem the device can count systems of full binary, binary coded decimal, base ten through base three, etc. It can also perform in a divisional mode. Frequency of the unit is 10-30,000 cps. **Commercial & Industrial Div., Vector Mfg. Co.**, Dept. 42-2, Southampton, Pa.

Circle 458 on Reply Card



Servo Valves

Series 73 industrial servo valves are available in flow ratings of 1, 2½, 5, 10, and 15 gallons per minute at 1000 psi pressure drop and maximum signal. They have the following features to overcome the problem of oil contamination so often encountered in industrial applications: High spool positioning force, provided through the use of internal mechanical feedback; a large pilot-stage filter which is easily replaced in the field, and an optional separate pilot supply port to enable the use of a second oil supply which may be at a higher pressure and subject to more filtration than the second-stage supply. These pilot operated, closed center, four-way sliding spool valves have



. . . how to spend $3,000 and SAVE $200,000

Before DFI starts a program to automate products and processes in your plant, we always recommend a feasibility analysis. This is done for your protection. We work with you to see if 1) your production can be automated, 2) an expenditure for the new equipment is economically justified; i. e. what is the "payout." DFI is a unique engineering company. We're only interested in finding how to produce your products at the lowest possible cost. We may recommend that 1) you buy standard equipment or machinery, 2) we design special equipment and (a) buy it for you from a machine tool builder, (b) build it in our own plant. To hear more about the way we approach a manufacturing engineering program . . . just write or call Ervin J. Osterhus, Executive Vice President.

DFI
Designers for Industry, Inc.

Manufacturing Systems Division
CLEVELAND
4241 Fulton Parkway · Cleveland 9, Ohio

write for new brochure on Manufacturing Engineering

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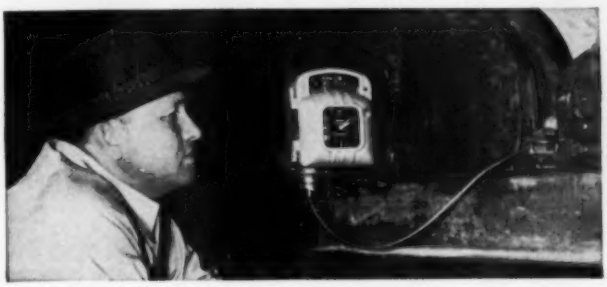


At Randolph Mills . . .

A WAGNER® INDUSTRIAL RECORDING SYSTEM

helps maintain production line efficiency

Randolph Mills uses Tachographs to measure production efficiency and time. When one shift in finishing fell far behind production, a Tachograph showed that the wash range machine wasn't draining water fast enough . . . pinpointed the situation that needed correction.

Tachographs are precision recording devices that can be used anywhere the control of speed, time and measurement is essential to the quality of your products. They can help you determine production peaks and valleys, and non-productive time. Chances are, they can help increase your plant's efficiency. Mail coupon below for full information.

Wagner Electric Corporation
6430 PLYMOUTH AVE., ST. LOUIS 33, MO., U. S. A.

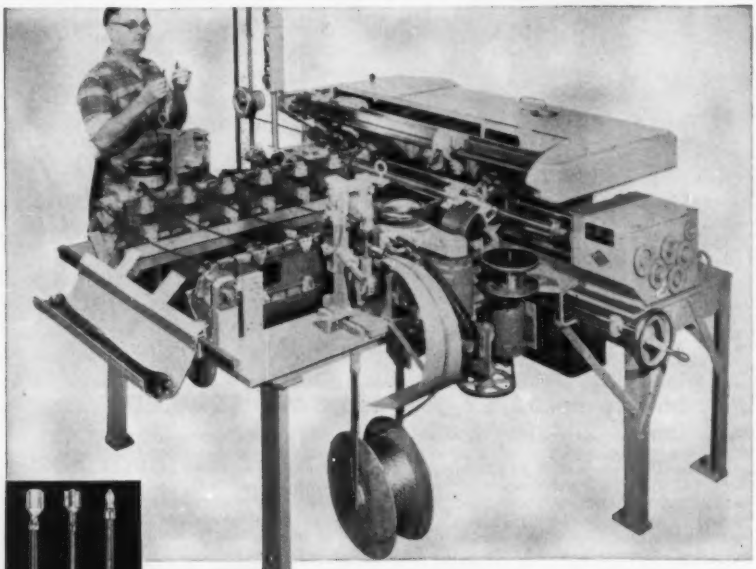
Please send a copy of Bulletin SU-144.

Name_____
Company_____
Address_____
City & State_____
Proposed Application_____

W161-3

Circle 710 on Reply Card

Produce 4,000 finished wire leads per hour...with terminals at both ends!



NEW ARTOS CS-9-AT AUTOMATIC MACHINE

1. measures any type of wire.
2. cuts off wire to length.
3. strips one or both ends.
4. attaches terminals at both ends.
5. provides stations for other work.

NOW YOU CAN produce up to 4,000 finished wire leads per hour—*with terminals attached at both ends*—when you install this new high-speed machine.

The ARTOS CS-9-AT handles almost any type of wire automatically. Taking wire from the reel, it measures, cuts to length, strips insulation, attaches terminals and provides uniform collection of the finished leads. Most types of terminals in prefabricated strip form can be used.

Also, the machine is furnished with a multi-station conveyor that permits several stations to be used for secondary operations such as inspection, twisting, welding, etc.

Get the complete story on the new ARTOS CS-9-AT—ask for engineering advice on your special problems.

ARTOS CS-9-AT CAPACITY

Wire Sizes: 20-gauge to 4-gauge.
Cutting Lengths: 6" min. to 90" max.
Stripping Lengths: 3/16" to 1½".
Output: 6"-45" lengths—4,000 per hr.
45"-90" lengths—2,000 per hr.

Write for Free Bulletins

Bulletin 358 describes CS-9-AT machine. Also ask about other Artos machines to handle wire from 30 to 000 gauge; cut lengths from 2 in. to 45 ft.; strip insulation from 3/16 in. to 10½ in.

AGENTS THROUGHOUT THE WORLD

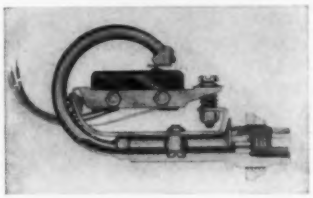
World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.

2785 South 28th Street • Milwaukee 46, Wisconsin

a symmetrical design which minimizes null shift due to pressure or temperature changes. They are available from stock; custom designs also can be produced. **Industrial Div., Moog Servocontrols Inc.**, P. O. Box 8, East Aurora, N. Y.

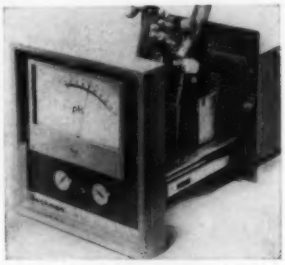
Circle 459 on Reply Card



Pressure Switches

Set and reset accuracy of ±0.5 per cent and proof pressures to 18,000 psi are features of line of bourdon tube pressure switches. Single-setting and dual-control stripped switches form the basic unit to which standard housings or explosion-proof housings are added to suit specification requirements. Five classes of adjustable range provide a choice of settings from 50 to 12,000 psi. All housed switches are equipped with integral terminal blocks for wiring convenience and economy, and the explosion-proof housings have built-in potting wells. Mounting lugs are provided on housed models; stripped switches are designed for panel mounting. **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 460 on Reply Card



pH Analyzer

Model J industrial pH analyzer system includes an analyzer, electrodes, and electrode mounting chambers. Analyzer employs an ac stabilized amplifier which provides stability of 0.01 pH/24 hours over −20F to +122F ambient temperature range. Output accuracy and meter sensitivity is ±0.02 pH for the full 0-14 pH range. Available with both milliampere and millivolt output for use with any potentiometric or current-type recorder, analyzer is also available with millivolt output only. By disconnecting two plugs, entire chassis can be removed from case. Glass and reference electrodes shown feature short, compact bodies for added strength. Electrode immersion and flow chambers are available for all application requirements. **Scientific & Process Instruments Div., Beckman Instruments Inc.**, Technical Information Dept., 2500 Harbor Blvd., Fullerton, Calif.

Circle 461 on Reply Card

CHROMALOX ELECTRIC HEATERS

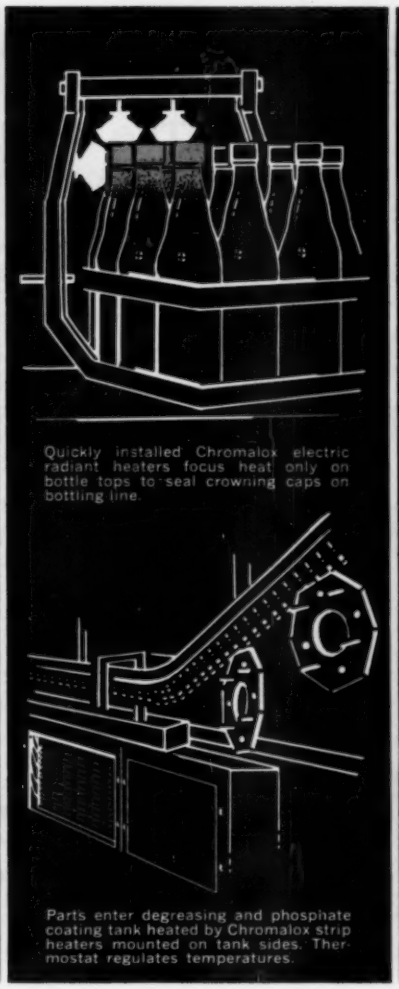
provide precise, uniform heat centers on automated operations, regardless of product size or shape

Precise control, from 4 to 100% of output, can be made an integral part of a Chromalox far-infrared heating installation. Temperatures are "dialed."

Compact far-infrared units interlock into self-forming ovens. Single or double heat sources in lengths from 24" to 185", many wattages.

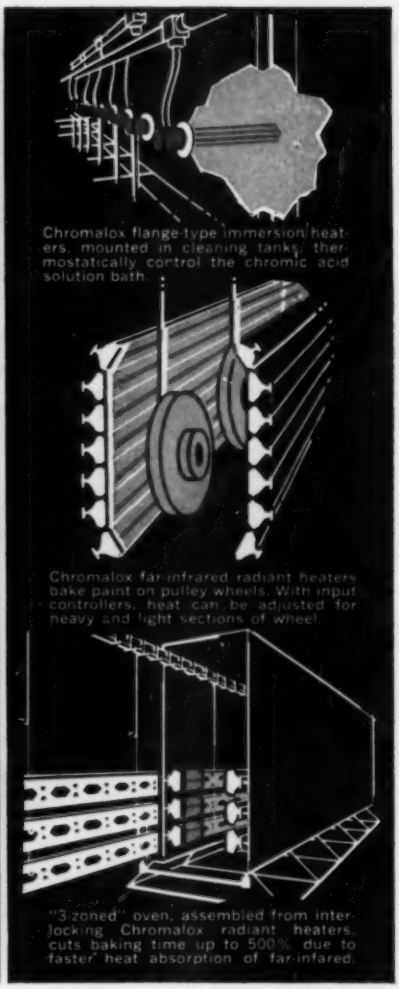
Straight lengths, formed or "finned" Chromalox strip heaters in 50 to 6,000 W; ¾", 1", 1½" widths; 5" to 96" lengths.

Chromalox immersion heaters — for heating water, oil and other liquids. 3" to 14" pipe flanges — with or without built-in thermostats.



Quickly installed Chromalox electric radiant heaters focus heat only on bottle tops to seal crowning caps on bottling line.

Parts enter degreasing and phosphate coating tank heated by Chromalox strip heaters mounted on tank sides. Thermostat regulates temperatures.



Chromalox flange-type immersion heaters, mounted in cleaning tanks, thermostatically control the chromic acid solution bath.

Chromalox far-infrared radiant heaters bake paint on pulley wheels. With input controllers, heat can be adjusted for heavy and light sections of wheel.

"3-zoned" oven, assembled from interlocking Chromalox radiant heaters, cuts baking time up to 500% due to faster heat absorption of far-infared.

Chromalox electric heating equipment can help you automate your production lines to cut costs, improve production and/or reduce rejects . . . as well as solve many of the critical heating problems encountered in line production. They are frequently used to boost existing heat-source temperatures. Among the Chromalox advantages are easy, low cost installation; dependable and economical operation; minimum attention and maintenance. Whatever your need for heat—whether for production-line or other processing applications—Chromalox electric heaters can provide exactly the heat source you require. Engineering assistance is available without obligation. Write, wire or phone.

FOR YOUR INFORMATION

Write for Catalog 60. It details uses for electric heat and describes thousands of types, sizes and ratings of Chromalox units.

EDWIN L. WIEGAND COMPANY

7746 THOMAS BLVD., PITTSBURGH 8, PA.

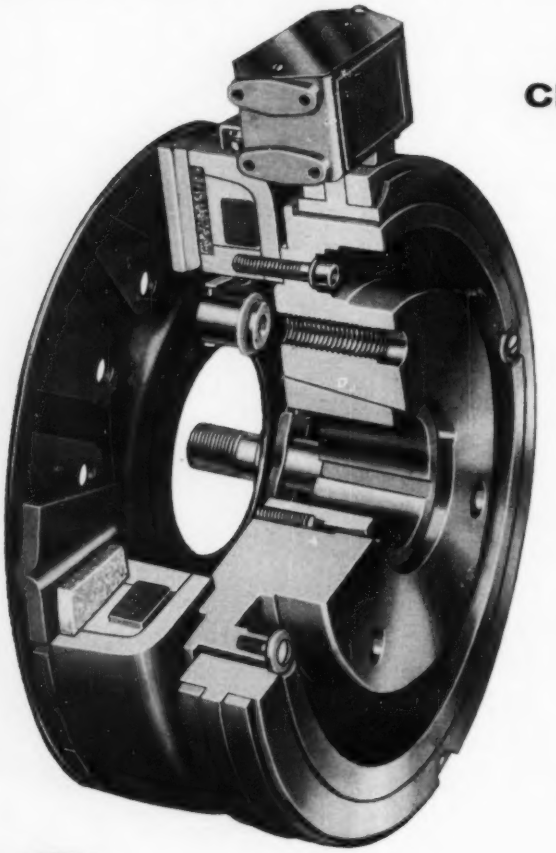
WI-24

CHROMALOX — FIRST NAME IN ELECTRIC HEAT

CHROMALOX ELECTRIC HEAT

PROCESS | COMFORT

EATON
DYNA-TORQ®
MAGNETIC-FRICTION CLUTCHES and BRAKES



The Ideal Solution to Exacting Clutching and Braking Problems

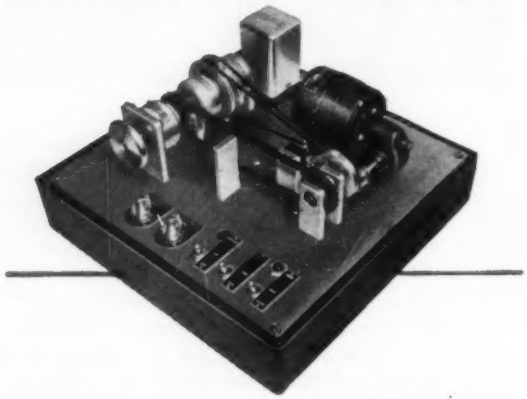
These highly responsive, trouble-free units provide accurate control of intricate automatic machinery. Operating on 6, 12, 24 or 90 V.D.C., Dyna-torQ units may be actuated by micro-switches, photo-electric cells, relays or any "ON-OFF" signal to perform a wide range of functions in processing and fabricating applications. The compact rectifier type control converts AC power to DC power and may be remotely mounted out of busy machine areas.

Eaton Dyna-torQ Clutches and Brakes are available from 1¾" through 15" in diameter. They may be easily and quickly installed on either new or existing plant equipment. Exclusive features of design and construction mean worthwhile savings.

HP @ 1800 R.P.M. *(Typical Application)*

MODEL	HP	MODEL	HP
302	1/20	308	7½
303	⅓	310	10
304	1	312	20
305	2	315	25

Dyna-torQ Distributors in many principal cities carry Dyna-torQ Clutches and Brakes in stock for immediate delivery.



Ask your Dyna-torQ Distributor to demonstrate Dyna-torQ in action and see for yourself the many possible applications for Dyna-torQ in Motion Control and Power Transmission.

EATON

ACCURATE POWER CONTROL

DEPENDABLE MOTION CONTROL

RAPID RESPONSE • LOW MAINTENANCE COST

EASY BUILT-IN INSTALLATION

WIDE RANGE OF SIZES AND CAPACITIES

Send for Illustrated Literature.

EATON DYNAMATIC DIVISION
MANUFACTURING COMPANY
3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

AUTOMATION

catalogs and literature

Free copies available from manufacturer. Use convenient Readers' Reply Card.

Shear Calculator

Verson Allsteel Press Co., 9300 *S. Kenwood Ave., Chicago* 19, *Ill.—4 page bulletin and slide calculator*—Bulletin VHS-61 gives design details and specifications for a line of hydraulic shears. The slide calculator simplifies the computation of the tonnage required to shear all commonly used metals. It may also be used to determine quickly whether an available shear has sufficient capacity for a given job, or what maximum thickness of any type of plate can be sheared in an available shear.

Circle 462 on Reply Card

Electronic Counter

Electronic Controls Div., Veeder Root Inc., 5 Maple St., Danvers, Mass.—4 page pamphlet—Covered in this bulletin is a Series 181709 electronic counter for liquid measuring systems. The counter calibrates flow meters under test and features a built-in instantaneous gating device. Details are provided on how the gating device automatically starts to count when the gate is open and stops counting when it is closed. Special features of the counter which make it ideally suited for refineries, bulk liquid transfer, and storage stations are covered.

Circle 463 on Reply Card

Optical Terminology

Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.—2 page pamphlet—Data sheet entitled "Glossary of Optical Terminology" is the first in a continuing series of terminology glossaries. It covers a wide range of technical terms from aberrations to surface reflection. Glossary is specifically designed for use as a reference work by engineering and other industrial executives and as a teaching aid by educational institutions.

Circle 464 on Reply Card

Data Acquisition System

Consolidated Systems Corp., 1500 S. Shamrock Ave., Monrovia, Calif.—16 page booklet—Brochure 3047 provides illustrated technical data on a MicroSadic digital data acquisition system, capable of sampling several hundred channels of analog data at up to 15,000 samples per second. This system converts analog information to equivalent digital form and records it on magnetic tape in either binary or binary coded decimal mode. Included in the bulletin is a brief functional description of all of the system's major components.

Circle 465 on Reply Card

Induction Heating Unit

Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, *Ill.—2 page pamphlet*—Bulletin 1521 details the features and equipment of a radio frequency heating unit, designated Model LI-15D-1. This unit is a vacuum-tube type converter designed to convert power-line energy to high frequency electrical energy suitable for induction heating. It provides 15 kw with 400 kc and 4 mc outputs. Operation is either manual or automatic.

Circle 466 on Reply Card

Industrial Brushing Tools

M. W. Jenkins' Sons Inc, Cedar Grove, N. J.—14 page booklet—Entitled "Standard Nomenclature for Construction of Industrial Brushing Tools," this booklet illustrates various forms of brush construction for industrial applications. Large cross-section drawings illustrate the characteristics of power-driven cylinder brushes, twisted-in-wire brushes, strip brushes, and others. Methods of setting the bristles are also shown, and component parts of each type of brush are shown and identified.

Circle 467 on Reply Card

Pressure Transmission Devices

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, *Ohio—3 pamphlets*—Product Specification Sheet G21-4 describes Mini-Line differential pressure transmitters for transmitting differential pressure measurements to indicating, recording, and/or controlling equipment at remote locations. Specification Sheets P21-4 and E21-4 describe pneumatic and electrical pressure transmitting mechanisms respectively. Details are given regarding applications, standard ranges available, operating characteristics, indicating scales, physical characteristics, and theory of operation.

Circle 468 on Reply Card

Weldable Strain Gages

Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, *Mass.—1 page bulletin*—Line of weldable strain gages is described in Product Data Sheet 4324. These gages afford electrical stability and high linearity of response over a range of temperatures up to 750F, and offer temperature compensation to plus or minus one part per million per degree F from 50 through 250 degrees. Technical information is given on the use of the gages for applications where standard types of strain gages cannot be used.

Circle 469 on Reply Card

Process Control Center

Republic Flow Meters Co., Subsidiary, Rockwell Mfg. Co., 2240 Diversey Parkway, Chicago 47, *Ill.—4 page pamphlet*—Covered in Bulletin 239.12A is a unified process control center. Details are provided on a line of compact equipment for combining readout and control functions with a four-inch strip chart recorder in a single panel assembly. Photographs of the various components comprising the center are furnished as well as an installation diagram.

Circle 470 on Reply Card

Ball Valves

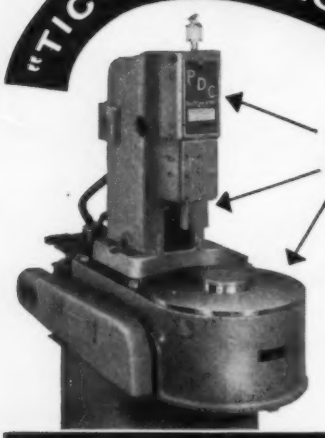
Hills-McCanna Co., 400 Maple Ave., Carpentersville, Ill.—32 page catalog — Catalog 1200-A provides detailed information on a line of manually operated and pneumatically operated ball valves. The valves range in size from ¼ inch through 12 inches with screwed, socket weld, and flanged end models for temperatures from −150 to 1000 F, pressures to 1000 psig, and vacuum to 10^{-6} mm Hg. Two basic types of valves catalogued are: The McCannaseal, a top-entry valve which permits maintenance without removing the body from the line; and the McCannaflo, a valve with one-piece bar stock body and end adapters.

Circle 471 on Reply Card

Industrial Gas Data

Air Reduction Sales Co., Div., Air Reduction Co. Inc., 150 E. 42nd St., New York 17, *N. Y.—48 page handbook*—Booklet lists physical and chemical properties of oxygen, nitrogen, argon, helium, hydrogen, carbon dioxide, acetylene, neon, krypton, and xenon. Similar information is included on the medical gases—ethylene, nitrous oxide, and cyclopropane. Conversion tables provide a simple and fast method for changing volumetric information on the various industrial gases from

"TIC-TOCK AROUND THE CLOCK"...



PDC Air-operated Toggle Action Press Head Shown

Standard risers available to increase shut height

PDC-EMUC-15 Electric Drive Index Table

PDC
"AUTOMATIC"
DIAL ASSEMBLY PRESS
... Range to 6 Tons

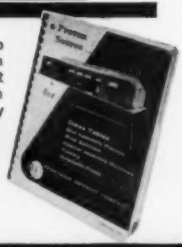
A PROVEN FACT: the PDC Automatic Dial Assembly Press *increases* production and *lowers* costs, and has proven itself in production for many years. It can be either hand-fed or hopper-fed.

This Standard Dial Assembly Press is for operations such as

• Assembling • Staking • Riveting
• Pressing • Forming

This machine can also be furnished with spinner heads, rivet hammers, punch presses and many other types.

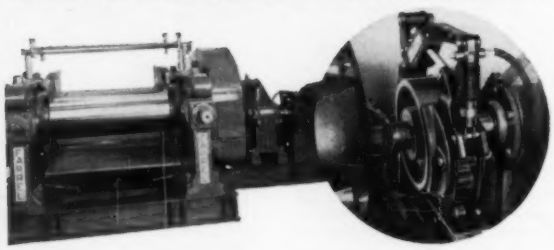
Write **TODAY** for new Catalog 60, for designers and engineers.



PRECISION DETROIT COMPANY
20100 SHERWOOD • DETROIT 34, MICHIGAN

Circle 714 on Reply Card

WAGNER® EMERGENCY BRAKE SYSTEM



Stops "Inrunning rolls" within safety limit

A Wagner® A/H Emergency Brake System protects the operator of this Farrel-Birmingham rubber mill against the hazards involved in operating machinery with inrunning rolls. An industrial-type brake is applied by an air-operated hydraulic power cluster to smoothly stop rolls well within the limit set by safety codes. The Wagner system minimizes strain on the machine drive, and incorporates safety devices that provide protection in the event of power failure or loss of air pressure.

Wagner brake systems are easy to install . . . don't need special motor starters or controls, or direct current. Need little care, too . . . there is practically no lining wear; no heavy solenoid coils to burn out.

Apply these systems to your rubber or plastic mills, refiners, washers, crackers. Available with 6, 8, 10, 14, or 18 inch diameter brakes. Get full details from your Wagner Sales Engineer.

Wagner Electric Corporation
6430 PLYMOUTH AVENUE, ST. LOUIS 33, MO., U.S.A. W161-4

Circle 715 on Reply Card

one equivalent unit of measure to another. Capacity data on industrial gas delivery and storage systems are also provided.

Circle 472 on Reply Card

Rotary Motion Transducers

Louis Allis Co., Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.—4 page pamphlet—Bulletin 200-A summarizes information on a line of digital Rotopulsers that convert rotary motion into electrical pulses. With measuring wheels, linear motions may be measured. Standard units provide up to 2400 pulses per revolution and measure speeds from 1/100 to 10,000 rpm. Rotopulsers are designed for use with process controllers, totalizers, add-subtract counters, draw indicators, special digital controls, and other types of readout and control devices.

Circle 473 on Reply Card

Digital Circuitry

Interstate Electronics Corp., Subsidiary, Interstate Engineering Corp., Marketing Dept., 707 E. Vermont Ave., Anaheim, Calif.—68 page handbook—Handbook provides data on various applications of digital circuitry. It includes chapters on basic logic design principles, graphic symbols, logic modules, and circuit configurations. A concise explanation of Boolean algebra and its use in development of logic circuits is provided as well as an analysis of logical processes.

Circle 474 on Reply Card

Electric Infrared Ovens

Radcor Inc., Advertising Dept., P. O. Box 432, Fostoria, Ohio—16 page booklet—Catalog reviews line of standard, temperature-rated electric infrared ovens for industrial applications. Details are provided on a temperature rating method of automatically providing the right oven once total time and maximum temperature have been determined. Catalog lists 540 vertical and 144 horizontal standard oven models.

Circle 475 on Reply Card

Industrial Waste Treating

B-I-F Industries, P. O. Box 276, Providence 1, R. I.—16 page booklet—Engineering Data Bulletin 3-SIC3900.21-1 deals with the problems of industrial waste treatment, classification of wastes, and the methods of solving these problems. Four general classes of waste for food, mineral products, chemical processing, and general industry, with their characteristics and strengths, are discussed. Equipment and processes used in unit treatment are detailed, including tanks, filters, aerators, chlorine gas feeders, vacuum filters, incinerators, sludge collecting, and pumping equipment.

Circle 476 on Reply Card

Interrogator Systems

Information Products Corp., 156 Sixth St., Cambridge, Mass.—24 page catalog—Technical brochure describes a line of random access file interrogators designed to solve the man-machine communications requirement associated with modern data processing operations. These systems include capability for both data inquiry and display, and for message composition and entry. They consist of a keyboard

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Self-contained pumping units furnish pressures up to 5000 psi, flows to 122 gpm. Packaged to help you . . .

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HORIZONTAL TYPE PUMPING UNITS *deliver constant or variable volumes up to 35 gpm at pressures up to 5000 psi. Available in 22 different models with 3 reservoir capacities—65, 110 and 165 gallons. Also available as JIC Series to meet exact specs—including reservoir capacities from 15 to 1000 gallons.*

HYDRAULIC POWER IN A PACKAGE for today's design engineering demands is compact, efficient and economical in these Denison pumping units:

Vertical Types are standardized oil hydraulic units—employing Denison axial piston and vane type pumps—with volume capacities from 2 to 18 gpm at pressures from 800 to 3000 psi. Reservoir capacities from 5 to 35 gallons.

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Horizontal Types (see photo) are high pressure units designed to meet a broad range of hydraulic power requirements. Six types of controls—from handwheel to servo—assure accurate delivery of any volume required.

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Write for Specifications Bulletins PU-3, PU-4, PU-5 and PU-6.

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PUMPS • MOTORS • CONTROLS

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for data entry and a cathode ray tube for data verification and display. Photographs of alpha-numeric and numeric interrogators are included in the brochure.

Circle 477 on Reply Card

Vertical Turbine Pump Motors

U. S. Electrical Motors Inc., P. O. Box 2058 Terminal Annex, Los Angeles 54, Calif.—30 page handbook—Manual has been devised to assist users in obtaining optimum operation and longest service life, and to enable maintenance men to save time and needless procedures in installing, inspecting, and servicing a line of Holloshaft vertical turbine pump motors. It covers Type HU oil-lubricated motors, Frame sizes 254 up through 445 up. Various factory developed procedures designed to minimize servicing efforts are outlined. Booklet is divided into three main sections: Installation, operation, and maintenance and repair.

Circle 478 on Reply Card

Electric Disc Brakes

Stearns Electric Corp., 120 N. Broadway, Milwaukee 2, Wis.—4 page pamphlet—Covered in this brochure is a line of ac and dc electric brakes which mechanically and automatically re-adjust themselves to compensate for lining wear resulting from use. Brakes virtually eliminate maintenance, making them especially important for applications involving rapid cycling or mounting in inaccessible locations. Series 87,000 disc brakes are available in 10 through 105 lb-ft torque ratings with standard and dust-tight waterproof enclosures.

Circle 479 on Reply Card

Cams and Camshafts

Eonic Inc., 464 E. Hollywood, Detroit 3, Mich.—6 page pamphlet—A wide range of cams and camshafts are described in Bulletin 210. Face and cylindrical cams; two and three dimensional cams; aircraft cams; master cams; hydraulic pump cams; and cams for wrapping and packaging special machinery are graphically illustrated. Details are also provided on a digital computer for the programming of cams.

Circle 480 on Reply Card

Data Acquisition System

Genisco Inc., 2233 Federal Ave., Los Angeles 64, Calif.—4 page pamphlet—Ten-channel analog-to-pulse duration system is described in detail in this folder. System is available to industry for precision applications in process control through direct digital conversion of analog input from dc sensing devices. Folder gives rundown of the system's operation and capabilities for use with thermocouples, resistance thermometers, or strain gage transducers to monitor, record or control temperature, pressure, stress, or voltage.

Circle 481 on Reply Card

Bottle Uncaser

Economic Machinery Co., Div., Geo J. Meyer Mfg. Co., 60 Fremont St., Worcester 3, Mass.—4 page pamphlet—Universal uncaser, Model FDU-8UF is subject of Bulletin FD-101. Machine utilizes interchangeable nylon finger assemblies for completely automatic uncasing of all standard and most nonstandard bottles with neck diameters from ⅝ inch to 1⅛ inch. They remove bottles from full-depth and half-depth return cases common in the beverage industry, from flapped shipping cartons, and from shipper trays used for new glass.

Circle 482 on Reply Card

Center-Of-Gravity Locators

Dynametrics Corp., Northwest Industrial Park, Burlington, Mass.—4 page pamphlet—Brochure 350 describes in detail the features, operating theory, and applications of three weight and center-of-gravity locators. These devices are capable of handling a wide range of test specimen configurations, ranging in weight from 1 pound to 250 pounds, and provide accuracies of ±0.1 to ±0.02 per cent of full scale. Various models are described, from basic, manually operated, single-axis machine to a semiautomatic, dual-axis device with options such as remote digital readout, explosion-proof construction, etc.

Circle 483 on Reply Card

Meter-Relay Circuits

Assembly Products Inc., Chesterland, Ohio—24 page handbook—Details regarding a line of locking contact meter-relays, including operating features and standard circuits for achieving the most popular types of control actions, are contained in Bulletin No. 5. Besides describing a continous reading meter-relay which requires no reset, the bulletin covers isolated coils, double locking coils, response time and damping, and overload protection and control components used with meter-relays.

Circle 484 on Reply Card

Conveyor Systems

Control Engineering Co., 8900 Roselawn Ave., Detroit 4, Mich.—8 page pamphlet—Brochure 61-1 presents a comprehensive coverage of systems controls and components for modern conveyor installations. It covers controls for dragline, power and free, monorail, overhead, and roller conveyors. In addition to automatic dispatching techniques, such products as memory units, low voltage relays, timers, limit switches, synchronization components, and shielded conductors for cranes and monorails are featured.

Circle 485 on Reply Card

Specialized Production Facilities

Danly Machine Specialties Inc., 2100 S. Laramie Ave., Chicago 50, Ill.—12 page booklet—Brochure FB-1 presents data regarding this company's welding, machining, assembly, engineering, and other facilities. These facilities are geared to handle a wide range of manufacturing jobs from the production of small precision parts and controls to the fabrication of machinery weighing hundreds of tons. Illustrated are a number of unusual jobs accomplished by this company.

Circle 486 on Reply Card

Hydraulic Power Packages

Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.—4 page pamphlet—Bulletin 61-82 describes a line of motorized hydraulic power packages featuring a special design in which the pump is connected directly to the extended shaft of the electric motor. All models in

VIBRON VIBRATORY FEEDER

PATENTED PNEUMATIC DRIVE provides POWERFUL PRECISE FEEDING.

Ideal for EXPLOSION-PROOF INSTALLATION

Full range control moves difficult materials. Glass-fibre springs. Dynamically balanced base. U.S. Pats. and Pats. Pending.

Model 400

1½ x 14 trough delivers up to 1500 lbs per hour horizontally.

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with the stainless steel stomach!

Air lines get dirty even in the best of plants. Dirt stops most valves, and production. But a Numatics valve keeps on working.

We don't say it's impossible to jam a Numatics valve but you can't hurt it with dirt. Why? The hardened, stainless steel, lapped spool and sleeve—unique in the industry. No resilient seals to get chewed up, or seize after long shutdowns. Working smoothly with millionths of an inch clearance, the stainless sleeve and spool—with razor sharp lands—will digest a diet of cast iron, aluminum, and steel chips, and foundry sand.

A Numatics valve will keep on working (even improve with service) under conditions that would stop an ordinary packed valve dead.

Any wonder we call Numatics valves the most reliable in the industry?

Buy Numatics—and relax.

The lapped spool and sleeve.
It works, and works, and works.

NUMATICS, Inc.

Highland, Michigan

ELECTRIC INFRARED PROCESSING EQUIPMENT ALLOWS MANUFACTURERS TO COUNTDOWN TO A NEW MINIMUM TIME REQUIREMENT IN MANY INDUSTRIAL HEATING APPLICATIONS

The Fostoria Infrared process is partly responsible for the quality built into the products you see here. Its speed breaks bottlenecks in production techniques. Its flexibility allows adjustment to new conditions with a minimum of effort. Its versatility provides economies unheard of in convection heating equipment. If you use heat in your manufacturing process, make a note to check with Fostoria about how to improve product quality with this time-saving, money-saving, labor-saving electric infrared equipment.

For temperature requirements under 900° F. send for folder "Applications Unlimited."

For temperature requirements from 900° to 3000° F. send for "Breakthrough" folder.

COUNT DOWN

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MANUFACTURERS OF ENGINEERED RADIANT ENERGY EQUIPMENT AND CRITICAL WORK AREA LIGHTING

three available series are rated up to 1500 psi, and include overload relief valves. Series PKS1, with outputs to 8 gpm, is available with one or two solenoid operated directional valves. Series PKM1, with outputs to 8 gpm, has up to three manually operated directional valves. Series PKM6 includes basic models without control valves and is available in outputs to 5 gpm.

Circle 487 on Reply Card

Directional Control Valves

Oilgear Co., 1571 W. Pierce St., Milwaukee 4, Wis.—2 bulletins—Line of two, three, and four-way directional control valves is covered in Bulletin 80200-A and 80300-A. Valve sizes from ½ inch to 3 inches for pressures up to 3000 psi are described. Information included covers: Construction features; dimension data; capacity and specification data; photographs; flow diagrams; ASA symbols and type designations for all sizes and types of valves. These valves are available with a complete line of hand lever, clevis, roller, hydraulic, and solenoid pilot operators.

Circle 488 on Reply Card

Stored-Energy Switchgear

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.—40 page catalog—Catalog 2800-2B features data on a line of 4.16 and 13.8 kilovolt circuit breakers and switchgear developed specifically for stored energy closing. Details are given on such features of the equipment as face-wound blowout coils and closed-door drawout. Also included are numerous drawings, sketches, photographs, specifications, and charts.

Circle 489 on Reply Card

Conveyors

Standard Conveyor Co., North St. Paul 9, Minn. — 4 page pamphlet — Booklet, designated Conveyorama, illustrates a number of ways to cut costs with conveyors. Included are photographs of a low-accumulation-pressure live roller; clamp type carton stackers; high speed continuous vertical lifts; and a complete system for ordering and dispatching small items from remote multifloor storage areas.

Circle 490 on Reply Card

Air Control Products

A. Schrader's Son, Div., Scovill Mfg. Co. Inc., 470 Vanderbilt Ave., Brooklyn 38, N. Y.—48 page catalog—Catalog 125 covers a line of air control products for automating in-plant operations and for component use in new products. The equipment ranges from cylinders, valves, and rotating joints to filters, regulators, quick-acting couplers, and hose fittings. Information is included on dimensions, flow rates, and operating pressures, and a number of typical air control circuits are described.

Circle 491 on Reply Card

Elapsed Time Meters

General Electric Co., Schenectady 5, N. Y.—4 page pamphlet—Bulletin GEZ-3354 contains data regarding a Type 236 elapsed time indicator. The unit is ideal for applications such as testing electronic components and equipment operating life,

Circle 719 on Reply Card

determining the operating times of electrical machinery, and scheduling machine inspection and servicing routines. Models are available for panel mounting, in protective conduit cases, and in portable stands. Reset devices can be incorporated.

Circle 492 on Reply Card

Tape Controlled Turret Drills

Burgmaster Corp., 15001 *S. Figueroa St., Gardena, Calif.*—16 *page booklet*—Illustrated and described in this catalog is a line of 6 and 8-spindle tape controlled turret drilling, tapping, milling, and boring machines. Four basic models covered include 2BHT, 25AHT, 3BHT, and 3BHT-B. The procedure for programming work and making tape is explained. Features and optional attachments are described.

Circle 493 on Reply Card

Semiconductor Devices

Kearfott Semiconductor Corp., 437 *Cherry St., West Newton, Mass.*—8 *page bulletin*—Booklet contains condensed specifications for a line of semiconductor devices. Charts indicate various types of semiconductors available and such features as maximum absolute rating, typical characteristics at 25C, switching characteristics, and small signal characteristics.

Circle 494 on Reply Card

Cam-Operated Indexing Units

Standard Tool & Mfg. Co., 738 *Schuyler Ave., Lyndhurst, N. J.*—16 *page booklet*—Bulletin 26 details a line of Model ST-A9AB indexing units for automatic production and assembly. The units are designed for light to medium duty and are available in either a basic or precision model. A comprehensive load rating table and load calculation methods are included as well as a nomogram for weight and moment of inertia calculations and a torque rating table.

Circle 495 on Reply Card

Manufacturing R & D Service

Manufacturing Systems Div., Designers for Industry Inc., 4241 *Fulton Parkway, Cleveland* 9, *Ohio*—14 *page booklet*—Brochure on manufacturing research and engineering explains how to analyze machinery investment and how to decide when and what to automate. Discussed are case histories on setting up completely new manufacturing facilities, revising antiquated production facilities, deciding what operations to automate for greatest return, and analyzing the investment for an assembly machine.

Circle 496 on Reply Card

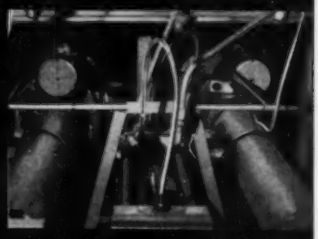
Materials Handling Equipment

Jervis B. Webb Co., 8951 *Alpine Ave., Detroit* 4, *Mich.*—4 *page pamphlet*—Designated Vol. 3, No. 8, this brochure presents some of the latest concepts in materials handling as applied to automatic warehousing. Several types of conveyors are covered. These include floor conveyors, roller conveyors, overhead tow conveyors, electronic tractor trucks, and stacker cranes. Photographs illustrate the various pieces of equipment.

Circle 497 on Reply Card

Where actuating control and precision are paramount

—like in a giant supersonic wind tunnel



—or a precision machine tool

you'll find "BEAVERS"

BEAVER ball screws are specified by engineers around the world for control of motion. Compressing solid steel wind tunnel walls, 1600 feet square against inconceivable pressures and holding error to .008" in an 8 foot stroke—or extreme accurate 3 dimension positioning of numerically controlled machine tool are all "naturals" for this equipment.

Can your product be made more efficient with Beaver Ball Screws? Write for literature.

Beaver Precision Products INC.
CLAWSON, MICH.

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BEAVER BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

Beaver Precision Products INC.
CLAWSON, MICH.

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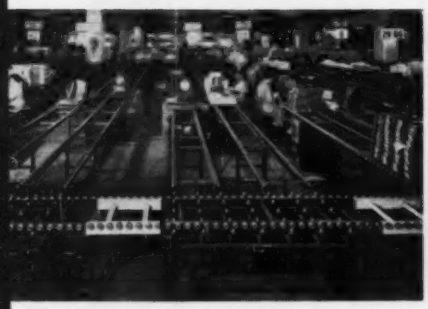
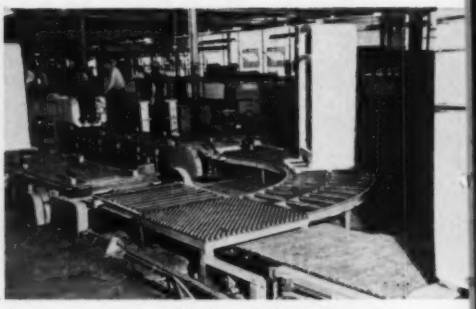
CUT YOUR HANDLING COSTS



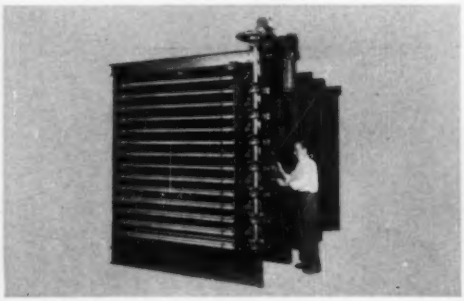
Single-row wheel conveyors as used in department store marking rooms

Powered belt conveyor. Horizontal and inclined with rubber, canvas or wire mesh belts

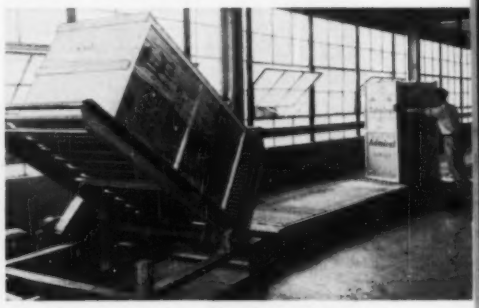


Apron conveyor assembly lines, ball-transfer switching station, in major appliance plant

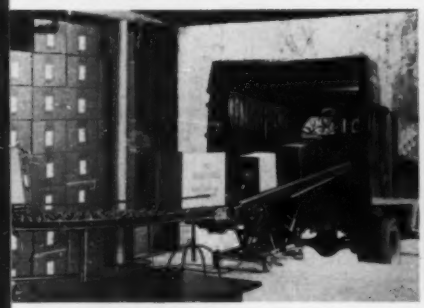
Overhead cable and roller conveyors, as used in wholesale drug warehouse for order picking



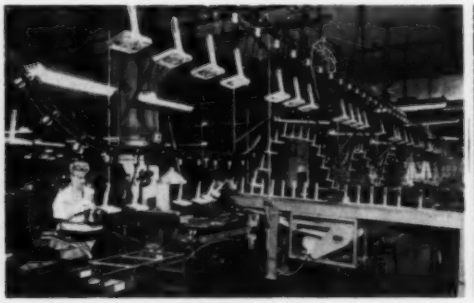
Automation. Special sheet feeder receives, stores and automatically loads and unloads curing press



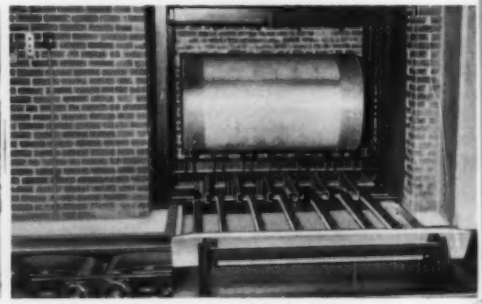
Up-enders, down-enders and special units are easily integrated into standardized conveyor systems



Portable wheel, belt conveyors: versatile in warehouses; shipping, receiving docks; stock rooms, etc.



Trolley carries light to medium weight loads, up, down, around all operations, at convenient heights



Automatic reciprocating hoist, belt conveyors handle paper rolls between floors in publishing plant

WITH BUSCHMAN CONVEYORS

ENGINEERED FOR ANY NEED IN ANY INDUSTRY

Buschman is your most logical source for a complete line of materials handling equipment, because they offer exceptional basic patent features and experience-engineering. From portable in-stock gravity conveyors to their famed Bush-Lock powered cable units, the Buschman line effects the greatest economy of space and handling costs in *any* situation. Here are a few typical applications that suggest how Buschman can serve *you*. The E. W. Buschman Company, 4551 Clifton Avenue, Cincinnati 32, Ohio.

Write for information on Buschman powered systems and in-stock gravity units for your use.

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CONVEYORS

Complete Conveyor Systems for all industries — Engineered, Manufactured, Installed.
Representatives in Principal Cities. See Yellow Pages. 373

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AUTOMATION abstracts

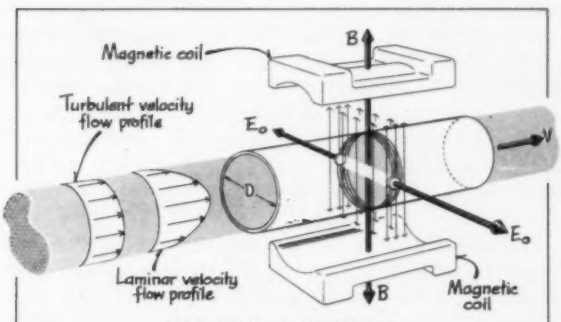
ELECTRONIC FLOW MEASUREMENT

By DOUGLAS R. LYNCH
Product Manager
Fischer & Porter Co.
Warminster, Pa.

BASIC needs that have prompted a revolution in flowmeter technology are manifold, but a few of the more important ones are: 1. The need for a simple, inexpensive, universally applicable obstructionless flowmeter. 2. The need for primary metering devices more closely allied to the complete electronic computer control system—a major goal of the process industries. 3. The need for special purpose flowmeters, for instance the intra- and extra-corporeal measurement of blood flow. 4. The need for a simple direct mass flowmeter.

The general, rapid acceptance of the ac magnetic flowmeter is indicative of the market potential for any metering device that meets the criteria cited.

Operation: This type of flowmeter is based on the fact that when any liquid which is a good electrical conductor is passed through an electromagnetic field at right angles to the direction of the field, a voltage is produced along an axis normal to the direction of motion and the direction of the field. The amplitude of the voltage will vary directly with the velocity of the conductor through the field. This, of course, is Faraday's Law of Electromagnetic Induction. As applied to flow metering, the law results in the equation shown with *Fig.* 1.



MAGNETIC FLOWMETER

q = Volume flow rate, cu ft/sec

E_o = Flow signal voltage delivered to secondary, volts, = BVD

B = Flux density, volt sec/sq ft V = Flow velocity, ft/sec

D = Effective bore diameter, ft

k = Flow coefficient $q = k\left(\frac{\pi E_o D}{4B}\right)$

Fig. 1—Industrial ac magnetic flow meter can be used to handle various liquids with notable exception of those with very low conductivity, hydrocarbons, and molten metal.

Note that the flow rate in a pipe of a given diameter is related to the variation of three quantities, K, E_o, & B. K is equal to unity for all liquids with conductivities above 20 micromhos/cm. Electronic means for correcting for changes in K between 0.1 micromhos/cm and 10 micromhos/cm have been investigated.

Since the strength of the field will change the measured voltage, it is necessary to compensate this factor. One method is to measure the ratio of E_o/B by establishing the reference voltage for the measuring circuit from a transformer connected in series with the field coil windings. Thus, any change in B will be reflected by a proportionate change in E_o. This then assures that the volume flow rate value is always correct.

Because the signal voltage is derived from the entire area between the electrodes, output will be correct for any axis-symmetrical flow profile as long as the field remains uniform. This means that the meter will not be affected in any way by viscosity. Usually nonsymmetrical profiles will so slightly affect the output that they need not be considered a problem, thus the meter is said to be unaffected by piping configurations.

The magnetic meter is unaffected by density as, in its strict sense, the meter is a pure velocity device. In any given pipe section the volume rate of flow is directly related to true average velocity as the area is constant. Thus, the meter becomes a universal volume flow device regardless of changes in density.

If the direction of velocity reverses, there is a 180 degree change in the signal phase, thus the meter may by utilized for bidirectional measurement.

Practical Considerations: The ac magnetic flowmeter, though not a panacea for all flow problems, is the immediate answer to many heretofore unmeterable or very difficult to meter liquids such as paper stock, sewage, heavy slurries, ultra-high viscosity liquids, and the strongest acids. For such applications, the meter has the following advantages:

1. No obstructions. The meter is, essentially, merely a length of straight pipe. Thus it will pass any material capable of being passed through the line.

2. Unaffected by fluid conditions. Unlike any other flowmeter, changes in viscosity, density, piping, temperature, pressure, or consistency do not affect operation.

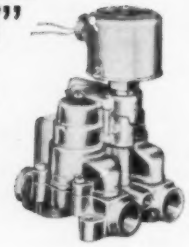
3. Extreme range. The instrument will meter from the most infinitesimal volume to the maximum that can be rammed through the pipe.

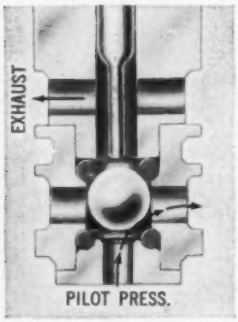
4. Corrosion resistant materials of construction. As the inside surface of the meter must be an electrical insulating, nonmagnetic material, fully corrosion resistant material such as teflon,

EXCLUSIVE!

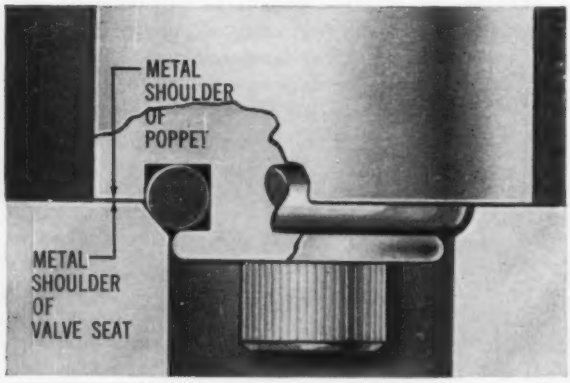
"NO 'O' RINGS TO STRANGLE THE PILOT PLUNGER OR MAIN VALVE POPPET"

This can be said about only one solenoid pilot air valve





The pilot plunger of the CRESCENT® "Mach 2" air valve requires no "O" rings. A free-moving ball in the pilot cartridge makes the seal. No "O" ring drag on the plunger; no friction; no wear.



The main poppet seals are merely kissed by the sealing surface in the sealed position. Metal shoulders take the shock, metal against metal. "O" rings are only minutely flexed; do not fatigue or lose resilience. Where else can you find a poppet valve where a metal piece doesn't come crashing down on a rubber seal causing wear?

"MACH 2" OFFERS OTHER EXCLUSIVES. Get the whole story. Call your Barksdale representative or write for catalog.

CONTROL VALVE DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

vitreous enamel, fiberglass or others may be used. The electrodes can be stainless steel, platinum, titanium, or other corrosion resistant metal.

The meter lends itself to many interesting and useful system application possibilities. Such systems are made possible through the use of a variety of secondary instruments compatible with the primary element. For instance, the basic flowmeter becomes an inferential mass flowmeter when secondary slidewires or electronic controls are added and the meter is combined with a density or percent solids gauge. The meter may also be tied directly into computer controls.

The ac magnetic flowmeter suffers from only one significant disadvantage: It will not measure certain liquids. Molten metals must be handled by the dc version and neither unit will function with liquids of very low conductivity or with hydrocarbons. The economic disadvantage of high cost can be justified by efficient performance. In time, larger production of meters, and more intensive competition, will precipitate a reduction in the prices that are now considered excessive.

DC Magnetic Flowmeters

Contrary to its ac counterpart, the dc meter has had only limited application because of a basic limitation in the range of fluids it can meter. The development and use of the meter has been generally within the nuclear power reactor industry. One of its first uses was on the original sodium engine where it indicated the important relationship between steam flow and sodium flow.

Operation: The dc meter is identical to the ac meter except for its use of a permanent magnet or a dc electromagnet to generate the field. However, unidirectional magnetic fields can be used only in those cases where polarization does not significantly affect measurement, for instance, in the liquid metal applications mentioned. Polarization is a phenomenon associated with aqueous or hydrogen-bearing solutions. When current flows, the positive atoms will tend to migrate toward the negative pole. They will disassociate and form a gaseous pocket of hydrogen. This acts as an insulator, thus making measurement of normal liquids in a dc field impossible. Being nearly perfect conductors, liquid metals do not evince a similar characteristic.

Practical Considerations: The major difference between the ac and dc meter is one of construction. One industrial version consists of a stainless steel tube in a permanent magnet structure. No liner or electrode is required. The output signal is picked-up off the pipe by two stainless steel wires which terminate in a two-wire coaxial-type connector.

Ultrasonic Flowmeter

Research for the development of an electronic flowmeter using sonic and ultrasonic techniques has been extensive. The total effort may even exceed that of the ac magnetic flowmeter, but the investment may prove worthwhile because, in theory at least, there is no limit to the range of liquids the ultrasonic meter

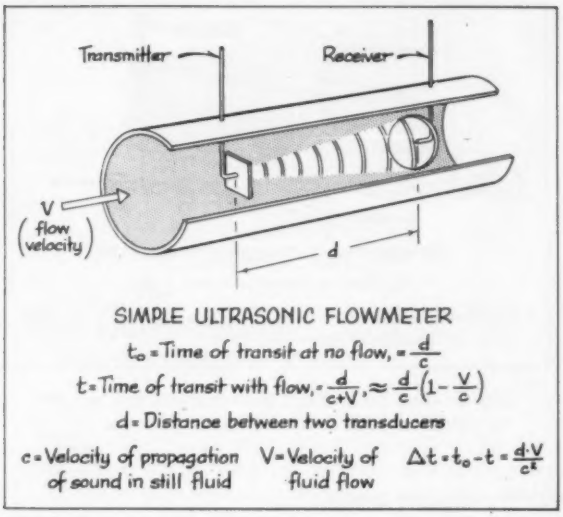

Transmitter
Receiver
V
flow
velocity
d
SIMPLE ULTRASONIC FLOWMETER
t_o = Time of transit at no flow, = $\frac{d}{c}$
t = Time of transit with flow, = $\frac{d}{c+V}$, ≈ $\frac{d}{c}\left(1-\frac{V}{c}\right)$
d = Distance between two transducers
c = Velocity of propagation of sound in still fluid
V = Velocity of fluid flow
$\Delta t = t_o - t = \frac{d \cdot V}{c^2}$

Fig. 2—Ultrasonic flow meter is based upon modification of apparent velocity of propagation of sound waves by the flow of fluid.

can measure.

Several manufacturers have advertised and displayed "industrial type" ultrasonic flowmeters, but performance often has not been sufficiently satisfactory to create a healthy market for the equipment.

Operation: While the principle of the ultrasonic flowmeter is simple—i.e. a liquid will conduct sound —applications of this phenomenon to a flowmeter are both complicated and varied. Most applications depend on the modification of the apparent velocity of propagation of sound waves by the flow of fluid. In simple terms, the apparent velocity of propagation between two fixed points in a pipe is the sum of sound propagation velocity (in non-agitated fluid) and the velocity of the fluid flow, *Fig.* 2.

A simplification of this technique that reduces errors in the measurement is to use two transmitters and receivers and measure the differential up and down stream, *Fig.* 3. The difference meter makes it relatively easy to establish zero flow because either t_1 or t_2 may be accepted as the base and the other time may be varied until the two are equal, i.e., the difference equals zero.

Both of these methods are dependent on the velocity of propagation squared, hence, small changes in this function can cause large errors. A unique variation of the difference method known as the oscillating loop or frequency difference method eliminates this problem, *Fig.* 4. Two separate oscillating loops are established, each having a transmitter and receiver. When a signal is received it immediately retriggers another burst of ultra-sonic energy thus establishing a loop frequency.

In a given pipe, the beat frequency (frequency difference) is in direct relationship to the flow velocity and completely independent of the velocity of propagation. An added advantage is that the beat frequency is easily measurable, being roughly 20 to

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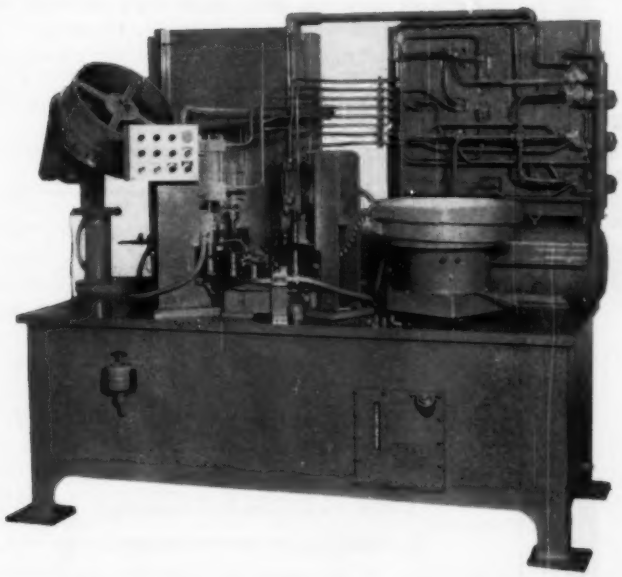

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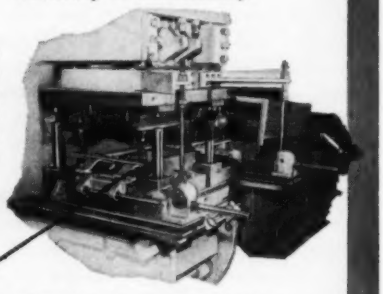

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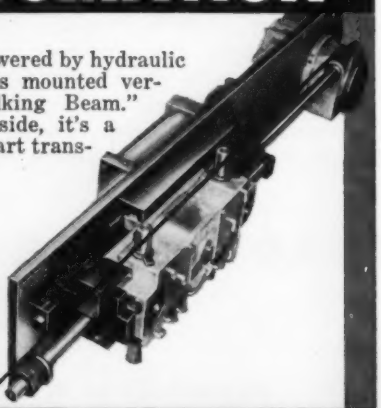

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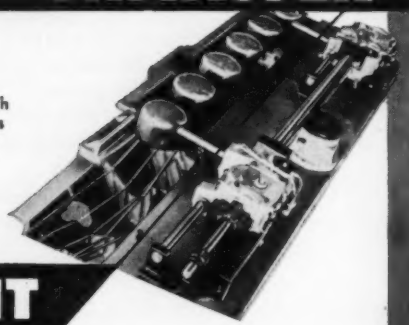

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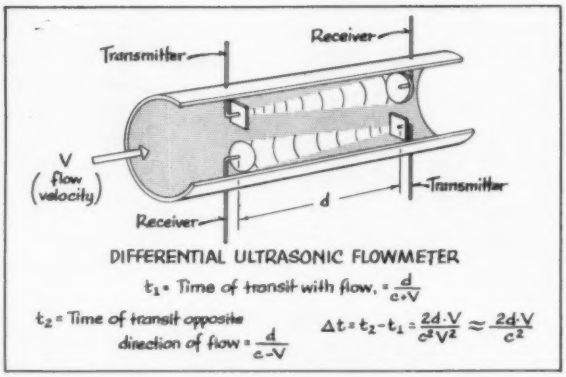

Transmitter
Receiver
V
(flow velocity)
d
Transmitter
Receiver
DIFFERENTIAL ULTRASONIC FLOWMETER
t_1 = Time of transit with flow, = $\frac{d}{c+V}$
t_2 = Time of transit opposite direction of flow = $\frac{d}{c-V}$
$\Delta t = t_2 - t_1 = \frac{2d \cdot V}{c^2 V^2} \simeq \frac{2d \cdot V}{c^2}$

Fig. 3—Two transmitters and receivers can be used to obtain a differential ultrasonic flow meter.

2000 cycles per second.

The last ultrasonic technique to be discussed measures the deflection of a beam across a pipe, *Fig.* 5. In this measurement method, the transducer produces a narrow beam of ultrasonic waves across the pipe and normal to the direction of flow. With a flow in the pipe, the beam will deflect downstream. Under conditions of no flow, a differential receiver at the end of the beam receives an equal amount of energy on each side. Under flow conditions one side receives greater energy than the other.

Practical Considerations: The advantages of the ultrasonic flowmeter are:

1. No measurement obstruction. Some versions function with the transducer on the outside pipe wall, others require a transducer through the pipe wall, in contact with the liquid but not protruding into the pipe.

2. No liquid restrictions. Theoretically, the meter will measure any liquid since all liquids will transmit sound energy.

3. Simple, direct mass measurement. Another transducer in the flow stream will produce a signal, proportional to density, which can be multiplied electronically by the volume to obtain mass.

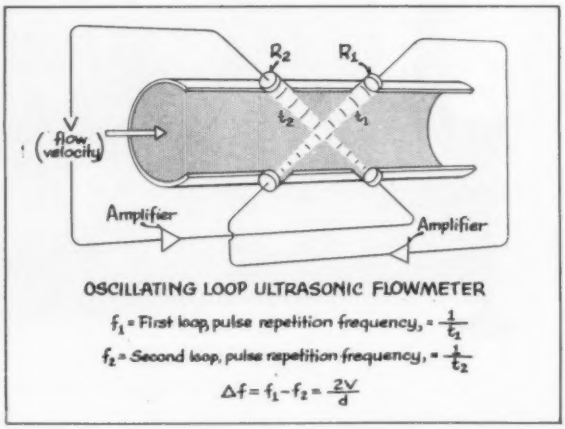


Fig. 4—Circuit design permits measurements of flow by technique in which frequency difference between bursts of sonic energy is directly related to flow velocity and independent of velocity of propagation.

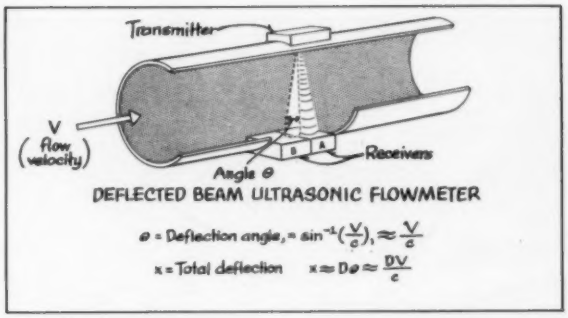


Fig. 5—Measurement of deflection of narrow beam provides an indication of flow.

Unfortunately, however, the advantages of the ultrasonic meter are outweighed by certain disadvantages. Until these are overcome, the meter can not become a universally used instrument. Here are the ultrasonic meter's basic disadvantages:

1. Complexity of measurement. In comparison with the average industrial instrument. A certain military version of the ultrasonic meter contained over a hundred transistors, its industrial counterpart almost 40 tubes.

2. Interruptions of the beam. Microscopic air bubbles along the pipe wall or transducer face act as a sound shield. Some slurries will scatter the beam completely. One solution to this problem is the use of a very low frequency with a wave length larger than the particle diameter or width but this creates other problems.

3. Measurement inaccuracies. Possible with even the slightest change in tolerance. With a velocity of propagation of 50,000 inches per second, a 4-inch pipe is traversed in 0.00008 second. Even a slight deflection in the pipe, or change in a transit time due to circuitry, could produce very large percentage errors.

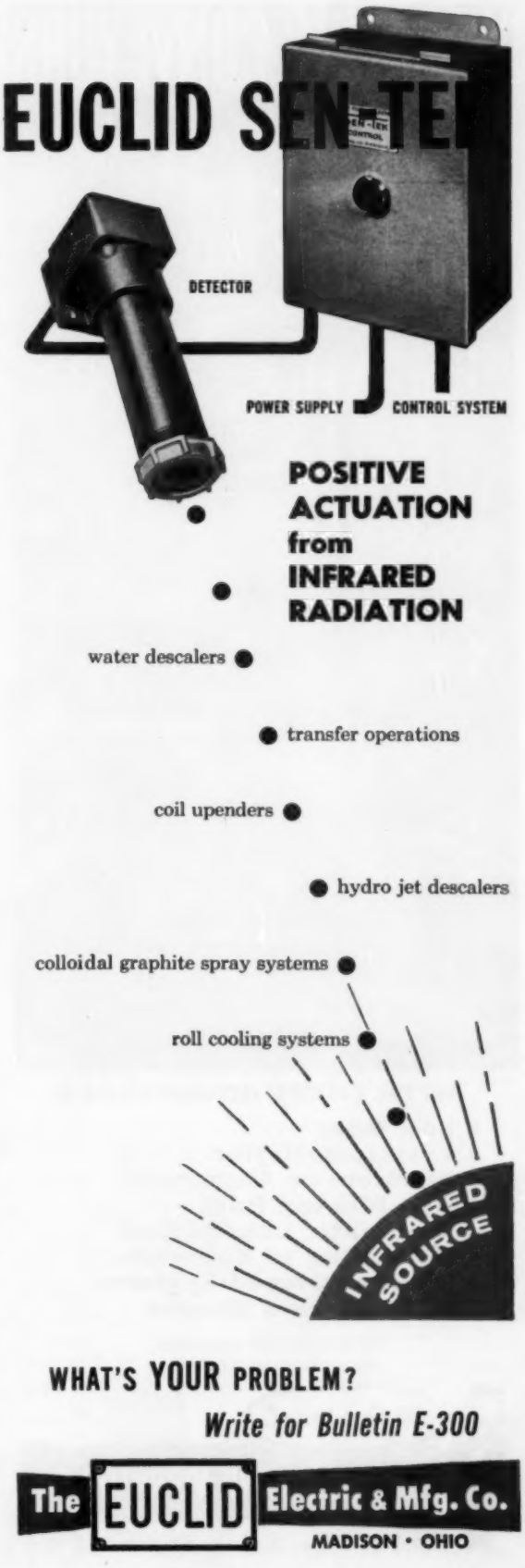
4. Hydraulic disadvantage. Since the meter usually uses a narrow beam, it is subject to changes in velocity profile. Though this can sometimes be minimized by proper placement of the transducers, long straight runs or flow straighteners would be needed to reduce the effects of piping configurations.

Thermal Flowmeters

The thermal flowmeter, also called the "boundary-layer" and the "electro-caloric" flowmeter, functions by electrically measuring the dissipation of heat during the flow of a liquid. This meter has not attracted wide interest, but it does have two noteworthy assets: First, such a meter is a direct mass flowmeter and second, it may be used for measurement of the flow of gases.

Operation: If heat energy is introduced into a medium flowing within a conduit and its temperature is measured before and after the heat exchange, the differential temperature between the upstream and downstream thermometer reading will vary with the rate of flow.

Mass flow rate may be measured by either of two methods. The first of these is a constant power, variable temperature differential technique by which the amount of power to the heater coils is maintained constant and flow is determined by the temperature differential between upstream and downstream temperature sensors. In the second method, the amount



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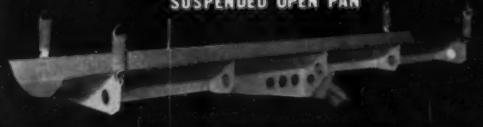

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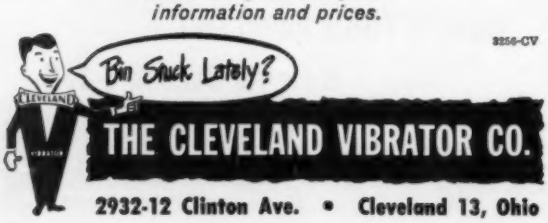

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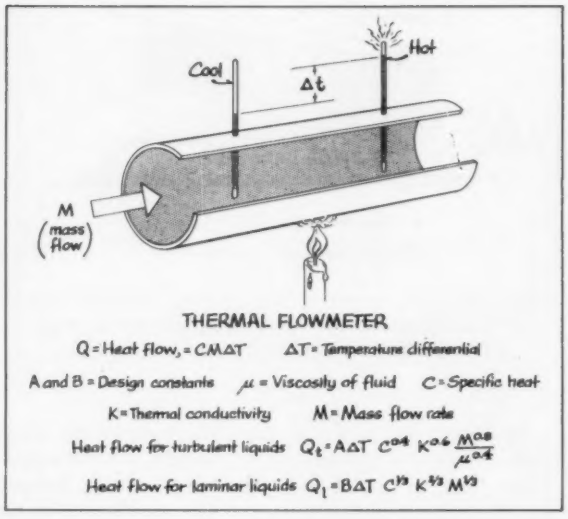
Cool
Δt
Hot
M
(mass flow)
THERMAL FLOWMETER
Q = Heat flow, = CMΔT
ΔT = Temperature differential
A and B = Design constants
μ = Viscosity of fluid
C = Specific heat
K = Thermal conductivity
M = Mass flow rate
Heat flow for turbulent liquids $Q_t = A\Delta T\, C^{.04}\, K^{.06}\, \frac{M^{.8}}{\mu^{.04}}$
Heat flow for laminar liquids $Q_l = B\Delta T\, C^{1/3}\, K^{4/3}\, M^{1/3}$

Fig. 6—Flow meter can be based upon measurement of difference in temperature between two points.

of heat (through a watthour meter) that is required to maintain a constant upstream and downstream temperature differential forms the measure of flow rate. Since the specific heat of certain liquids can change with ambient temperature, compensation coils may be built into the circuitry to reduce the error.

Practical considerations: The unique advantages of the thermal meter are:

1. It is a direct mass flow meter.

2. It can be adapted to a great range of fluids, both liquid and gaseous.

Mechanically, the metering section consists of a thin wall pipe contained within a heavier support pipe, thus providing obstructionless metering. The metering spool, on which are mounted the heat coils and temperature transducers, must be very thin to effect the best heat transfer. A good noncorrosive material must be used, because changes in the surface condition could change the relationship of heat flow to flow rate.

The drawbacks to the meter are:

1. It must be more or less custom designed for each application since a different formula applies for rather low or high Reynolds Numbers. Flow in the transition region should be avoided.

2. For absolute accuracies, the meter should be precalibrated on a master standard facility using the liquid to be metered, a difficult procedure. If only repeatability is desired, this drawback is not critical.

3. The thin wall tube limits, to some extent, the usable line pressure.

4. The mass flow noted above is of a pure liquid not of certain non-homogeneous mixtures, i.e. paper stock, sludge, etc.

5. Piping configurations, and secondary liquid phenomena such as pipe wall build-up, and large changes in the boundary layer due to very high viscosities, can also produce erratic operations.

From a paper entitled "Electronic Devices for Measuring Flow," presented at Joint Industrial Electronics Symposium sponsored by IRE, AIEE, and ISA at Boston, September 1961.

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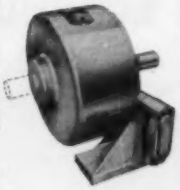

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Dates shown with suggestions indicate issue in which problem was presented.

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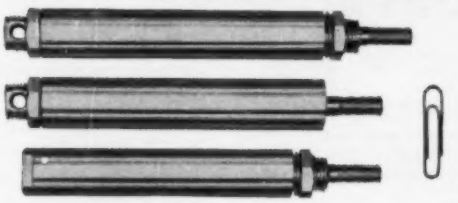

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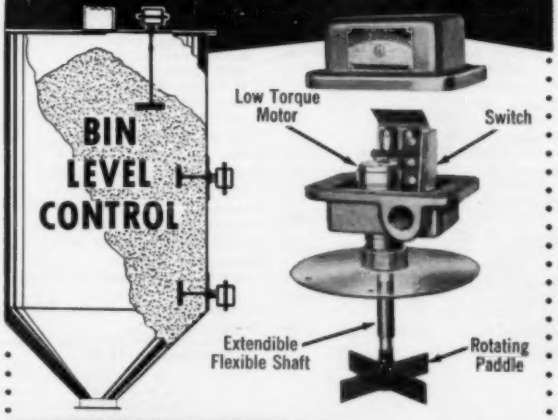

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CUMULATIVE EDITORIAL INDEX

Including July 1961 through December 1961. Number preceding hyphen is month of issue; those following are page numbers.
AUTOMATION *is indexed in the Applied Science & Technology Index and the Engineering Index, available in libraries generally. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.*

A

Actuator, electromechanical, 9-23*
Addressing magazine labels, 10-88
Adjustable-speed drives, 8-88; 10-63
Air systems, maintenance of, 8-77
Analysis, continuous process, 8-70*; 9-52
Analyzer,
  boiler water, 8-70*
  continuous process, 9-151
  process, 7-76
  silica and phosphate, 8-70*
  spectroscopy, book, 11-160*
Ankeney, H.
  Positioning Control Standards, 11-147
Argon, liquid, 8-12*
Arnold, H. H.
  Developing a Multimachine Complex, 9-52
Assembling, cards and envelopes, 12-66
Assembly, 9-39; 12-42
  automobile bodies, 6-41
  carbon resistors, 9-60
  cathode ray tube, 10-41
  incandescent lamps, 11-64
  micromodule, 8-12*
  shock absorbers, 9-39
  tire and rim, 11-41
Automation,
  and the office, 11-160*
  data processing, 8-54
  in Russian tire factory, 9-48*
  Italian Commission for, 7-57*
  philosophy, 7-53; 10-41
  survey, 7-35
Automation and Manpower, Advisory Committee, 7-53
  Office of, 7-53

B

Beck, P. W.
  Automatic Diode Tester, 7-67
Bleeker, V. C.
  Systems to Control Time Cycles, 11-90
Blending system, 9-23*
Bols, R. W.
  Automation Outlook, 12-9*
  Survey Report and Forecast on Automation Trends, 7-35
Boxing wire parts, prob., 7-148*
Brakes, 12-69
  electric, 10-78
Brenner, D. W.
  Air Supply Maintenance, 8-77
Brison, R. J.
  Mineral Processing, 10-158
Brokmeyer, D. E.
  Industrial Hydraulic Circuits, 9-80
Brown, R. W.
  Testing and Sorting Resistor Blanks, 10-81
Brown, W.
  Hydraulic Circuits to Avoid Overheating, 12-79
Building blocks, machine tools, 9-68
Burnishing, 11-41

C

Carpenter, J.
  Industrial Hydraulic Circuits, 7-83
Cartoners, 11-56
Casting,
  continuous production, 7-57*
  engine blocks, 12-33
Cement analysis, 9-151
Character recognition devices, 12-60
Chemical, metering movie, 7-16*
Chemical milling, 12-37*
Chope, H. E.
  Developing Control Systems, 7-76
Cleaning,
  coal, 9-75
  machine, 9-26*
  metal strip, 12-58
Clutches, 12-69
  electric, 10-78
Coating,
  epoxy equipment, 9-23*
  metal strip, 12-58
Compressors, maintenance of, 8-77
Computer,
  control manufacturing system, 9-52, 60
  routines, 12-14*
Computers,
  billet cutoff, 11-47*
  circulation control, 10-88
  control application, 9-76
  high-speed digital, 10-9*
  impact on plant maintenance, 11-84
  in data processing, 8-54; 11-77
  in production control, 12-55
  international standards, 11-50*
  management use, 9-153
  process control, 7-76; 9-60
Conference, Instrument Society of America, 8-12*
Connector, terminal, 10-22*
Controls,
  batch process, 9-155
  batch weighing, 9-67
  computer, 9-52
  computer applications, 9-76
  computer requirements, 10-155
  electric brake, 10-78
  electric clutch, 10-78
  electrohydraulic servo, 9-80
  for automatic assembly, 12-42
  gas dispatching, 10-70
  industrial motors, 8-162*
  lamp-making machine, 11-64
  mineral processing, 10-158
  multiple motor systems, 10-63
  order picking, 7-70
  photoelectric, 11-50*
  pneumatic, 8-47*
  process, 8-47*, 50*; 9-76
  process computer, 9-13*
  rubber cutting press, 7-54
  servo, 9-80; 10-75
  sorting machine, 10-81
  static machine, 7-9*
  system philosophy, 7-76
  timing, 11-90
  train routing, 9-45*
  with clutches and brakes, 12-69
Conveyors,
  copper cathodes, prob., 9-164*
  free and power, 11-63
  metal scrap, 8-72
  motor controls, 10-63
  order picking, 7-70
  overhead, 8-96
Copper and Brass Achievement Awards Competition, 12-16*
Core making, 12-33
Costs, reduction, 11-152
Counters, newspaper stacking, in, 7-95
Counting lumber, prob., 12-142*
Critical path scheduling, 11-84
Crystallography, 10-4*
Cunningham, J. B.
  Special Tools Can Be Versatile, 9-58
Current conductor system, 7-10*
Curry, B. W.
  Organizing for Effective Production Control, 12-55

D

Data handling, 11-77
Data processing, 8-53; 9-17*
  card reader, 8-14*
  coding paper tape, 11-14*
  communications center, 12-16*
  computer control system, 12-16*
  computer, electronic, 9-17*
  computer input data, 12-60
  control computer systems, 10-14*
  in the petroleum industry, 11-149
  information retrieval, 9-14*
  international standards, 11-50*
  list of equipment items, 8-54
  list of manufacturers, 8-54
  magazine subscriber, 10-88
  pneumatic computer, 11-17*
  random access memory, 11-13*
  storage equipment, 10-19*; 11-13*
  tape preparation system, 10-35*
  tape reader, 11-14*
  warehousing, 7-70
Decker, R. O.
  Control Computer Application, 9-76
Descaling steel strip, 10-87
Design, mechanical elements, 9-161*
Detecting breaks, prob., 10-161*; 11-156*
Dictionary,
  automation and computers, 10-162*
  physics and electronics, 8-162*
Diode, multiple germanium switching, 9-20*
Dispatching, natural gas, 10-70
Dispensing popcorn salt, prob., 9-164*
Drills, multispindle, 8-17*
Drives,
  adjustable speed, 8-88; 10-63
  hydraulic, 8-88

E

Economics, 11-55
  equipment investment, 10-52
  of automated assembly, 12-42
Electrical,
  brakes and clutches, 10-78
  level indicator, prob., 9-164*
Electrostatic painting, 10-85; 11-86
Engineering,
  an assembly machine, 12-42
  manufacturing, 7-62
  manufacturing development, 9-52
  systems, 11-55

F

Feeders, pneumatic, 10-81
Feeding,
  for packaging, 11-56
  metal webs, 8-79
  steel sheets, 10-48*
  tobacco, prob., 8-159*
Filters, air supply, 8-77
Finishing,
  glass, 10-58
  metal strip, 12-58
  plastic lenses, prob., 10-161*
Flaw detection equipment, 12-22*
Flexibility, production, 8-39
Flow measurement, 12-135
Fluid bed insulation, prob., 9-164*
Food processing, 11-65
Forecast, automation trends, 7-35
Forming,
  explosive, 10-159
  window glass, 8-87
Free and power conveyor, 11-63
Furnaces,
  carbon coating, 9-60
  vacuum arc, 11-24*

G

Gaging,
  air system, 10-41
  equipment, pneumatic, 9-22*
  glass blanks, 8-87
  mass spectrometer, 10-4*
  nuclear, 12-66
  thickness, 7-94
  x-ray emission, 7-94
Golovin, N. E.
  Reading Printed Data Electronically, 12-60
Grumich, E. H.
  Shall We Automate?, 12-43
Guide rings, 7-10*

H

Handling,
  automatic crane for, 12-66
  automobile bodies, 9-39
  bathtub molds, 10-59
  bread pans, 7-92
  bundles in newspaper mailrooms, 7-95
  cargo, 9-13*
  circuit cards, 11-71
  conveyor belt system, 7-21*
  conveyor system, 8-96
  dry materials, 8-30*
  feeding metal webs, 8-79
  for electrostatic painting, 10-85
  garments, prob., 5-142*
  gypsum, 10-58
  incandescent lamps, 11-64
  magnetic routing system, 7-16*
  mail sorting system, 12-16*
  metal strip, 12-58
  Naval warehouse system, 9-22*
  newspaper stacking, 7-95
  parts for assembly, 11-63
  parts transfer, 9-69
  pneumatic, 10-58
  porous panels for bins, 10-4*
  scrap collecting system, 8-72
  steel coils, 8-71
  steel pipe, prob., 8-159*
  warehousing, 7-70
Head, F. E.
  Programming Batch Processes, 9-155
Heating element, 12-29*
Hensgen, B. T.
  Automatic Disassembly, 7-143
Hertz stresses, in feeding webs, 8-79
Highland, A. A.
  Monitoring, Logging, and Control with Data, 11-77
Holloway, C. C.
  Preparing the Proposal, 12-48
Hutton, J. G.
  Create the Proper Climate, 8-154
Hydraulic instrument, pinpoints trouble, 11-28*
Hydraulics,
  adjustable speed drives, 8-88
  circuits to avoid overheating, 12-79
  counteracting gravity, 7-83
  electrohydraulic servo systems, 9-80
  high-speed press, 10-75
  multi-actuator system considerations, 7-83
  obtaining pilot pressure, 12-79
  position control systems, 9-80
  pump unloading, 12-79
  pumps and controls, 7-83
  sequencing fluid motors, 7-83
  sequencing multiple cylinders, 7-83
  sizing of components, 12-79
  supplying auxiliary circuits, 12-79
  velocity control systems, 9-80

I

Indexing,
  arrangements, 9-39
  by clutches and brakes, 12-69
  in transfer machines, 9-69
  large molds, 10-59
Information Processing Society, 8-12*
Inspecting hosiery, prob., 7-148*
Inspection,
  electronic machine, 8-20*
  in-process, 9-60
  shearing line, 12-68
  system, pallets, 7-92
Instruments, electronic, 9-161*
Investment, proposal analysis, 10-52
Irish, M. C.
  Transferring Methods, 9-69

J

Joining coil strip, 8-71
Justification,
  equipment proposals, 10-52
  of assembly machines, 12-42

K

Korin, S. B.
  A Look at Investment and Payback, 10-52

*Asterisks indicate brief items appearing in departments.

L

Labeling, 11-56
Labeling, magazine, 10-88
Labor-management,
  Presidential Advisory Committee on, 7-53
Lasher, C. C.
  The Challenge in Control, 10-155
Lathes,
  crankshaft, 8-39
  liquid, 7-9*
Learson, T. V.
  The Petroleum Industry Looks at Data Processing, 11-149
Load cells, 11-35*
Loading, cement barges, 10-86
Loranger, W. F.
  On-Line Process Analysis, 9-151
Lubricators, air supply, 8-77
Lynch, D. R.
  Electronic Flow Measurement, 12-135

M

Machine shop, tips and timesavers, 9-161*
Machine tool attachment, reciprocating feed arrangement for drilling machines, 10-25*
Machine tools,
  automotive, 11-41
  broaching, 10-37*
  building blocks, 9-68
  cutoff and deburring, 11-14*
  flame-cutting machine, 10-19*
  Japanese market survey, 9-48*
  modular for transfer line, 11-87
  numerically controlled, 10-14, 41, 67, 86
  tube processing machine, 10-28*
Machines,
  assembly, 12-13*, 42
  baling, 8-72
  cigarette making, 7-76
  circuit card testing, 11-71
  cleaning-coating, 12-58
  computer controlled, 9-60
  diode tester, 7-67
  drawing, tape controlled, 12-14*
  furnace, rotary retort, 12-20*
  furnace, vacuum, 12-25*
  heat treating, 12-13*
  lamp-making, 11-64
  laundering, 10-4*
  metal expanding, 11-41
  newspaper stacker, 7-95
  packaging, 11-56
  sorting, 12-68
  tire mounting, 11-41
  tube bending, 10-16*
  welding, 8-71
  welding, friction, 12-18*
  wiring, 10-16*
Magnetic,
  flowmeters, 12-135
  imprinting, 10-16*
  parts orienter, 11-82
  tape, subscriber data, 10-88
MacLeod, R.
  Automatic Batch Weigher, 9-67
Magnetic field sensing device, 9-20*
Maintenance,
  compressed air supply, 8-77
  electronic items, 7-146
  impact of computers on, 11-84
  test panel for, 9-22*
Making shoulder pads, prob., 9-164*
Management,
  concepts, 9-161*
  design of data systems, 8-162*; 11-77
  measurements, 10-162*
  philosophy, 9-153
  production, 10-162*
Manufacture of,
  aluminum foil, 7-94
  appliance transmissions, 11-87
  automobiles, 8-72
  automotive parts, 8-96; 12-33
  automotive pistons, 10-41
  ball point pens, 12-42
  bathtubs, 10-59
  cans, 8-47*
  ceramic products, 10-45*
  deposited carbon resistors, 9-52, 60
  diesel flywheels, 10-41
  esters, 9-155*
  frozen pies, 11-65
  hardboard, 7-58*
  hydrogen, 8-47*
  incandescent lamps, 11-64
  nails, 11-82
  printed circuits, 12-37*
  rubber mats, 7-54
  sanitary ware, 10-45*
  silicon surface alloy transistors, 9-14*
  steel beams, 8-50*
  steel billets, 11-47*
  window glass, 8-87
Manufacturing engineering, 7-62
Manufacturing Engineering Council, 11-17*
Marking,
  cartons, 10-86
  resistors, 9-60
  tubes, 7-92
Mays, B. L.
  Automation in Newspaper Mailrooms, 7-95
McRainey, J. H.
  Data—The Crucial Element, 8-54
Measuring,
  circuit delay, 11-71
  machine, tape controlled, 8-39
  mechanical, book, 11-160*
  paper stacks, prob., 7-148*
  viscosity, 8-50*
Meat packing, 7-143
Memory drum, 8-27*
Metal cutting, theory, 10-182*
Metal Show, 9-14*
Meyfarth, G. H.
  Handling and Baling Scrap, 8-72
Molding, cast iron bathtubs, 10-59
Morse, C. W.
  Manufacturing Engineering Today, 7-62
Motion control by clutches, 12-69

N

Neklutin, C. N.
  Intermittent Feeding of Metal Webs, 8-79
Numerical control, 9-158; 10-41
  in automotive plant, 11-41
  jig borer, 7-24*
  machine tool drive, 9-80
  multihead machine tool, 10-67
  standards, 11-147
  system, prob., 10-161*

O

Olson, H. A.
  Controlling Unwind Reels, 10-78
Order picking, 7-70
Order processing system, 9-14*
Organization,
  for manufacturing development, 9-52
  for manufacturing engineering, 7-62
  for production control, 12-55
Orienting, with magnets, 11-82
Orr, J. P.
  Explosive Forming, 10-159

P

Packaging, 11-56
  bottle caps, 12-66
  hospital supplies, prob., 8-159*
  nails, 11-82
Packaging Machinery Manufacturers Institute Show, 10-14*
Painter, mechanical, 10-4*
Painting,
  continuous metal strips, 12-58
  electrostatic, 10-85; 12-66
  electrostatic spray, 11-86
  machine, capacitor tubing, 9-29*
Payback calculations, 10-52
Peck, J. F.
  Controlling Motion with Electric Clutches and Brakes, 12-69
Perry, C. B.
  Tape Controls Multihead System, 10-67
Philosophy for automatic assembly, 12-42
Photo-etching, 12-37*
Piling, metal sheets, 12-68
Pipeline, nitrogen, 10-19*
Pipes, vinyl, 10-16*
Planning, production processes, 7-62; 9-52
Pneumatic,
  feeder, 10-81
  testing, 12-33
  weigh transmitter, 9-67
Position memory system, 7-92
Preparing drawings, prob., 12-142*
Press feed, portable, 11-36*
Presses,
  high-speed hydraulic, 10-75
  hydraulic, 10-14*
  rubber cutting, 7-54
  servo controlled hydraulic, 10-75
  sliding bolster, 8-39
Press slides, selective cycling, 9-39
Printers, magazine label, 10-88
Process,
  continuous casting, 8-24*
  fuel oil gasification, 8-47*
  ultrasonic, for bending plastics, 8-10*
Production control, 7-76; 9-60; 12-55
Programming,
  batch processes, 9-155
  crane system, 8-10*
  machine tools, 8-9*
  mill operation, 8-50*
  punch press, prob., 11-156*
  system, numerically controlled, 10-13*
  timers, 11-90
  train movements, 9-45*
Pulley, magnetic, 10-31*
Pumps,
  liquid metal, 10-48*
  variable displacement hydraulic, 10-16*
Punched card,
  order picking, 7-70
  steel mill operation, 8-50*

R

Railroads, automatic train routing, 9-45*
Raymond, C. T.
  Packaging in Manufacturing, 11-56
Reading,
  data inputs, 12-60
  machines, 12-60
  printed characters, 12-60
Recorders, bar chart, 11-25*
Regulators, air supply pressure, 8-77
Removing bow from strip, prob., 10-161*
Research, Science Information Service, 10-19*
Reservation system, 9-14*
Return on investment, 10-52
Ringo, J. F.
  The Proper Time to Reduce Cost, 11-152
Rinsing cans, 7-93
Rods, bronze coated, 9-27*
Rolling, aluminum products, 7-94
Rusnov, P.
  Planning Ensures Successful NC, 9-158

S

Schiller, J. D.
  Developing A Multimachine Complex, 9-52
Screw, teflon-coated, 12-30*
Seaman, H. A.
  Circuit Cards Tested Automatically, 11-71
Semiconductor application, 8-162
Semiconductor networks, 12-14*
Sensing, lines, prob., 7-148*
Separating chips from parts, prob., 10-161*
Separation, heavy media method, 9-75
Servo,
  controlled press, 10-75
  controlled systems, 9-80
  positioning systems, 9-80
Shartle, R. A.
  Industrial Hydraulic Circuits, 8-88
Sherwood, P. W.
  Computer Impact on Plant Maintenance, 11-84
Smith, O.
  Not More, but Better, 9-153
Snider, R. E.
  Maintenance for Production, 7-146
Solder applicator, 12-28*
Sorting,
  metal sheets, 12-68
  moving objects, 11-50*
  parcel post, 9-23*
  resistor blanks, 10-81
Source recording equipment, 8-54
Spreading shredded asbestos, prob., 8-159*
Statistical analysis of systems 11-160*
Step switch control, 11-90
Stephen, W. F.
  Testing and Sorting Resistor Blanks, 10-81
Stitching machine, for buttons, 9-35*
Storage, on power and free conveyor, 11-63
Stresses, in feeding metal webs, 8-79
Such, I. H.
  Double Challenge, edit., 12-41
Supervisory control, 10-70
Survey, automation, 7-35
Systems engineering, 11-55

T

Tape, controlled measuring, 8-39
Tapping,
  unit, 7-16*
  unit, dual-head, 8-22*
Technical reports, government, 8-12*
Telemetering, 10-70
Television, closed circuit, 9-39
Temperature meter for moving wires, 7-58*
Tension control, 10-63
Tester, terminal pull, 11-32*
Testing,
  cathode ray tubes, 9-32*
  circuit cards, 11-71
  cylinder heads, 12-33
  diodes, 7-67
  engine assemblies, 12-33
  resistor blanks, 10-81
  resistors, prob., 9-164*
  tape-controlled lathes, 11-31*
Thermal flowmeters, 12-135
Timers, 11-90
Tool units, packaged, 8-39
Tooling, for automatic assembly, 12-50
Train, remote control, 10-87
Transfer,
  devices, in transfer machines, 9-60
  line, convertible, 8-39
  machine, appliance parts, 11-87
  machines, 9-69
Transferring, parts in transfer machines, 9-69
Tullis, L. C.
  Assembling Pen Caps, 12-50

U

Ultrasonic flowmeters, 12-135
Ultrasonic testing, cylinder wall thickness, 12-33
Unwind reels, 10-78

V

Valves,
  electrohydraulic, 9-80
  remotely operated, 10-70

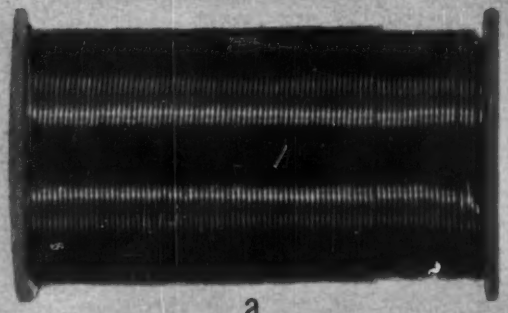
W

Warehousing, order picking, 7-70
Watson, T. J.
  Accept and Exploit, 8-158
Weighing,
  batch, 9-67
  glass blanks, 8-87
Welding,
  coil ends, 8-71
  electric resistance, 8-9*
Wheeler, W. A.
  High-Density Packaging System, 11-82
Wilburn, J. B.
  Making Incandescent Lamps, 11-64
Williams, J. C.
  Automatic Batch Weigher, 9-67
Williams, W. F.
  Monitoring, Logging, and Control with Data, 11-77
Winding rubber tape, prob., 8-159*
Wrapping bottles, 7-93

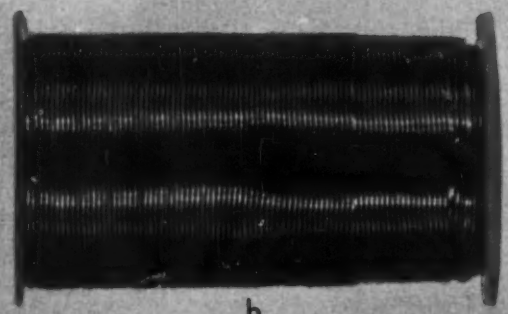
X

X-ray,
  emission gage, 9-151
  thickness gage, 7-94

Which coil was wound
AUTOMATICALLY
by the new
AMECO 511?



a



b

It's simple to find out. Just set the number of turns of wire you want per coil. Punch the start button. Now sit back and watch. The Ameco 511 loads the bobbins, winds the turns you want, trims the leads, tapes the outer periphery and unloads a perfect layer wound coil — coil after coil, as "B" above. And here's the exciting part: the wire diameter and bobbin length are determined automatically by a unique wire guide. Want to know more about how you can have perfect layer winding for your coils, like "B" above? Write:

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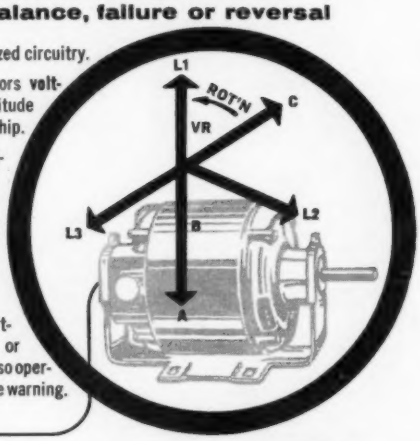

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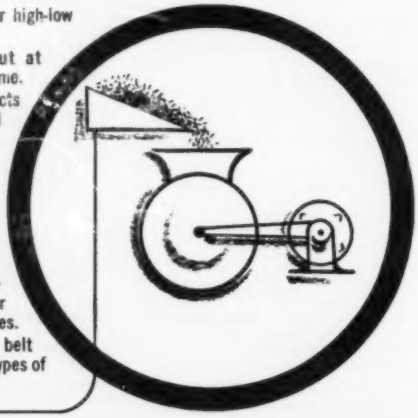

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Advertising Index

ACF Electronics Division, ACF Industries..... 8
ACF Industries, ACF Electronics Division..... 8
AMP, Inc. 96
Allis, Louis, Co., The 106, 107
American Brake Shoe Co., Denison Engineering Division 129
American Monorail Co. 109
American Monorail Co., The, Conveyor Division 143
Apex Machine & Tool Co., The 22
Artos Engineering Co. 30, 124
Assembly Products Inc. 114
Automatic Switch Co. .....Back Cover
Automation Machines & Equipment Co., Inc.... 146

Barksdale Valves, Control Valve Division..... 136
Beaver Precision Products Inc. 133
Bellows-Valvair, Division of International Basic Economy Corporation 102
Bin-Dicator Co., The 143
Burgess & Associates, Inc. 130
Buschman, E. W., Co., The 134

Carlyle Johnson Machine Co., The 29
Cincinnati Milling Machine Co., The, Cimtrol Division 108
Cincinnati Milling Machine Co., The, Milling Machine Division 6, 7
Cleveland Tramrail Division, The Cleveland Crane & Engineering Co. 31
Cleveland Vibrator Co., The 140
Clippard Instrument Laboratory, Inc. 143
Conveyor Systems, Inc. 15
Crown Zellerbach Corporation, Gaylord Container Division 23
Cutler-Hammer, Inc. 26, 27

Delavan Manufacturing Co. 119
Denison Engineering Division, American Brake Shoe Co. 129
Designers for Industry, Inc..... 123
Detroit Power Screwdriver Co. 120
DeVilbiss Co., The 81
Dynamatic Division, Eaton Manufacturing Co... 126
Dynapar Corporation 105

Eaton Manufacturing Co., Dynamatic Division.. 126
Emerson Electric Mfg. Co. 146
Euclid Electric & Mfg. Co., The 139
Ex-Cell-O Corporation, Machinery Division.... 32
Exact Weight Scale Co., The 38

Fairbanks, Morse & Co., Electronics Division.. 87
Finish Engineering Co., Inc. 24
Fosdick Machine Tool Co., The 91
Fostoria Corporation, The 132
Friden, Inc. 82
Fuller Co. 104

Gardner-Denver Co. 113
Gaylord Container Division, Crown Zellerbach Corporation 23
Gemco Electric Co. 142
General Dynamics Corporation, Telecommunication 28
General Dynamics Telecommunication, Stromberg-Carlson 28
General Electric Co. 40
Gray Equipment Co. 137
Greenlee Bros. & Co. 2

Hanna Engineering Works 1
Hickok Electrical Instrument Co., The 12
Hughes Aircraft Co., Industrial Systems Division 101

International Basic Economy Corporation, Bellows-Valvair Pneumatics Division 102

Livernois Engineering Co. 138
Logansport Machine Co., Inc. 36
Lucas-Rotax, Limited 111

Maico Electronics Inc. 122
Matthews, Jas. H., & Co. 110
Mead Fluid Dynamics, A Division of Mead Specialties Co. 11
Mead Specialties Co., Mead Fluid Dynamics Division 11
Micro Switch, A Division of Minneapolis Honeywell Regulator Co. 88, 89
Minneapolis Honeywell Regulator Co. 35
Minneapolis Honeywell Regulator Co., Micro Switch Division 88, 89
Moline Tool Co. 122

National Acme Co., The 93
National Vulcanized Fibre Co. 25
Numatics, Inc. 131

Oilgear Co., The 5
Omnitronics, Inc. 28
Ortman-Miller Machine Co. 17

Planet Corporation .....Inside Front Cover
Precision Detroit Co. 128
Precision Welder and Flexopress Corporation .....Inside Back Cover

Reuland Electric Co. 141

Sandvik Steel, Inc. 116
Sheffield Corporation, The, Contract Manufacturing Division 39
Simplicity Engineering Co. 143
Sperry Rand Corporation, Vickers, Inc., Division 20, 21
Spo, Inc. 95
Sta-Warm Electric Co. 142
Swanson-Erie Corporation 85

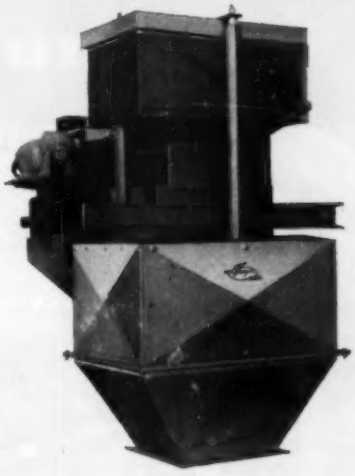
Thayer Scale Corporation 147
Toledo Scale Corporation, Toledo Scale Division 118
Toledo Scale Division of Toledo Scale Corporation 118
Tomkins-Johnson Co. 117
Trans-Weigh Co. 112

Union Switch & Signal, Division of Westinghouse Air Brake Co. 121
United States Steel Corporation, U. S. Steel Supply Division 19
United States Steel Supply, Division of U. S. Steel Corporation 19
United States Steel Corporation, Subsidiaries.. 19

Vickers, Inc., Division of Sperry Rand Corporation 20, 21

Wagner Electric Corporation 123, 128
Webb, Jervis B., Co. 148
Weighing & Controls, Inc. 112
Westinghouse Air Brake Co., Industrial Products Division 115
Westinghouse Air Brake Co., Union Switch & Signal Division 121
Wiegand, Edwin L., Co. 125

STOP PROFIT GIVE-AWAY



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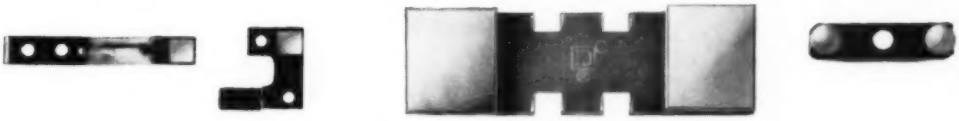
PRECISION Quarterly NUMBER 8

PRECISION WELDER AND FLEXOPRESS CORPORATION, 3520 Ibsen, Cincinnati 9, Ohio

Automated Welding Sure Way To Electrical Contact Economies



CHICAGO: Step into a progressive metalworking plant near here and you will find a line of 60 resistance welding machines fastening buttons.

Each month this one plant welds millions of electrical contact buttons to other electrical components. These buttons must be superior electrical conductors (which is why so many are made of fine silver), and above all, they must be reliable. This plant is achieving button-welding reliability of 999,996 perfect parts out of each million welded!

With understandable pride, we note that most of the machines in that reliable line are Magnetic Force welders built by Precision Welder & Flexopress Corp. of Cincinnati, Ohio. Precision is an old hand at reliable button welding.

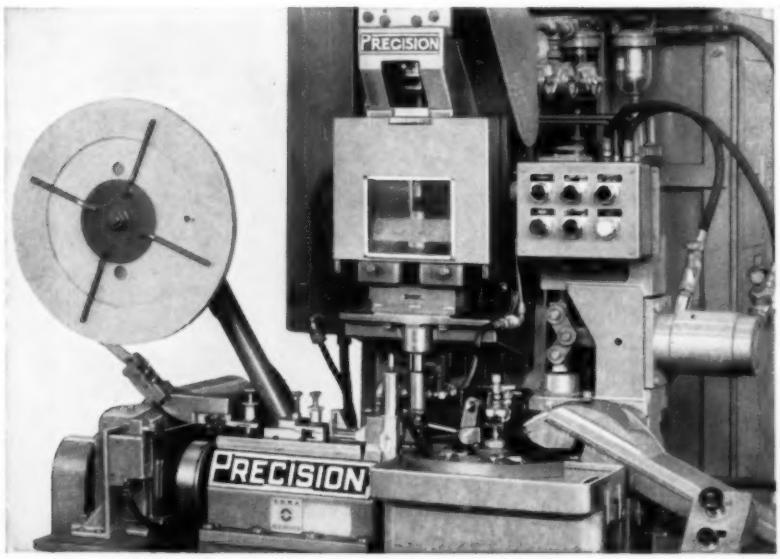
It's a big business, too. Your doorbell, thermostat, dishwasher, drier, toaster, waffle iron, telephone, and automobile would soon break down without reliable contacts. Industrial equipment is loaded with them.

Button welding can be tricky. Besides being difficult to weld directly to other materials, silver is costly. If you decrease the amount of silver and increase weldability by using contacts in which the silver is backed up with other metals, you often end up by increasing costs. However, a good proportion of our country's electrical manufacturing plants find that individual contacts of composite materials make sense for low volume production. Standard resistance welding machines can handle the work—whether welding, brazing, or silver soldering—on a slowpoke basis.

But when it comes to thousands of contacts a month, only welding automation (the kind pioneered by Precision) can really hold costs down. Contacts no longer have to be purchased ready-formed. Automated Precision Welders accept coiled ribbons of pure silver or composite materials, accurately measure and cut off contact blanks, orient them, assemble them to other components, weld the two together automatically, and coin to shape. Ingenious tooling can equip the same Precision machines to handle components of many different sizes and shapes.

In addition, Precision furnishes the electrical industry with Magnetic Force welders with hopper, magazine, dial, and in-line feeds for handling ready-formed contact buttons. You will also find Precision welders (and Flexopresses, too) doing the unusual and difficult jobs in automobile, appliance, communications, aircraft and many other metalworking categories.

If yours is a high-production welding task, or if it involves the welding of precious metals, dissimilar materials, large areas, or other out-of-the-ordinary situations, you ought to look into Precision. Especially if it's profits you're after. And who isn't?



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this is the way a valve is built to last

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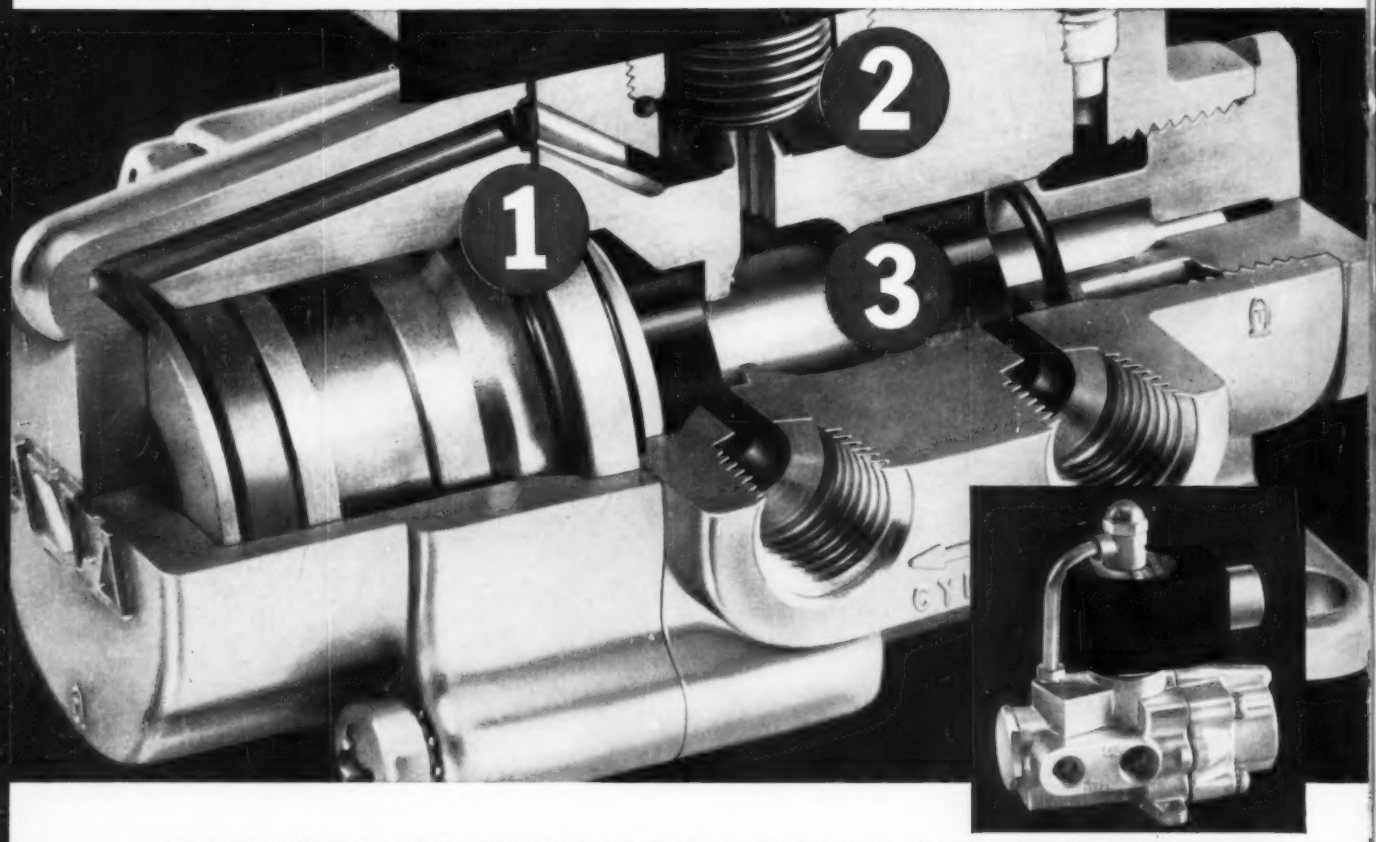

NEW LOW-COST ASCO 4-WAY SOLENOID VALVES HAVE BEEN CYCLED MILLIONS OF OPERATIONS WITHOUT FAILURE

1. **TIGHT SEATING** with unique patented poppet-type seats—Patent Nos. 2,624,585—2,775,982
2. **RELIABLE OPERATION ASSURED**—failure to return due to residual magnetism is eliminated
3. **POWER OPERATION IN BOTH DIRECTIONS**—main valve not dependent upon return springs

Installation is simplified; the 8344 may be mounted in any position!

Poppet seals and a unique combination of metal-to-metal with resilient seating enable these and other ASCO 4-way solenoid valves to provide dead-tight shut-off, even on air, without lapping, grinding or close adjustments. The utter simplicity of design, eliminating return springs and power-operating the main valve in both directions, assures unprecedentedly reliable performance without maintenance for indefinite periods.

The new ASCO Bulletin 8344 valve is the latest embodiment of over half a century's design and development experience. Its low cost makes it economical even as a 3-way valve, with one pipe connection plugged.

Here are the pertinent statistics:

Pipe Size	Catalog No.	Solenoid Enclosures	List Prices†	Operating Information
¼"	83440	Std.	$48.00	Pressures: to 250 psi.
¼"	83444	Expl. proof	56.00	Temp: to 212° F.
⅜"	83441	Std.	48.00	Fluids: air, water, hydraulic oil
⅜"	83445	Expl. proof	56.00	

† Subject to trade and quantity discounts.

Other ASCO 4-way valves come in pipe sizes from ¼" to 1½" for pressures to 500 p.s.i. For complete information write for Catalog 202, and see the hundreds of types of 2, 3, and 4-way solenoid valves available for immediate delivery from the world's largest stock.

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